The INSTITUTE Spokesman

DECEMBER • 1951

OFFICIAL PUBLICATION

NATIONAL LUBRICATING GREASE INST

NLGI


YOU GET MORE WITH MOREHOUSE
Spline driven rotor assembly simplifies maintenance.
24" x 67" —compact and versatile.
Double-bearing spindle assembly assures positive radial alignment.
Lightweight head is easy to remove.
Splined drive through flexible coupling eliminates transmission of thrust load to motor.
Polished processing chamber is easy to clean.
Model B-2005 available with or without dearator equipment
EXTRA
UP TO 25,000 LBS. PER HOUR
Your processing of greases, lubricants and compounds can be stepped up profitably with Morehouse Mills.
Here's the latest model . . . a model that has processed (milling and deaerating) as high as 25,000 pounds per hour. Deaerating rates as high as 1000 pounds per minute have been observed!
And . . . you get high production like this in a fraction of the space at a fraction of the cost of other mills. As a direct result of the Morehouse principle of high-speed milling and deaerating, you get products of improved appearance and texture . . . many being upgraded. This means better selling prices and better profits on your products.
Model B-2005, available with or without deaerator, is only one of a wide range of models designed expressly to increase your production at a profit. Why not investigate how you can get more with Morehouse?
External adjustment to adjust clearance between stones.
More production in a fraction of the space at a fraction of the cost.
Write for complete details TODAY!
MOREHOUSE INDUSTRIES
Originators of high speed stone milling equipment and sole manufacturers of Morehouse Speedline Mills
Factory and export sales: 1156 San Fernando Rd., Los Angeles 65
Cable address: "MORESPEED Los Angeles" • Eastern sales: 707 Henry Grady Building, Atlanta 3, Ga.

DOW CORNING

Silicone Notes

ON LUBRICATION

REFERENCE NO. SL-51

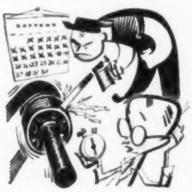
FILE SILICONE LUBRICANTS

Make sure you have basic data sheets BG-2, 5502, 7101. If misplaced write Department N-12

DOW CORNING CORPORATION
Midland, Michigan

DOW CORNING 44 GREASE

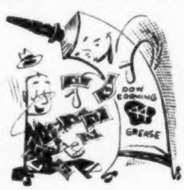
791 HOURS AT 400°F. plus 2033 hours of operation at 300°F. were ticked off before we reached an end point in testing bearings lubricated with Dow Corning 44 Silicone Grease. We used heat-treated, steel retainer bearings operating at 1750 rpm under a spring load of 150 pounds. After 250 eight-hour days at 300°F., we pushed the temperature up to 400. 791 hours later the bearing failed. That's at least 10 times the maximum life recorded for any organic grease tested at 400°F.



AFTER 754 HOURS at 390, 365 and 330°F. respectively, the life testing of Dow Corning 44 Grease in 3 similar bearings operating at the same speed under the same load was discontinued. Only the 390° bearing showed sign of failure. Under the same conditions, other bearings were operated at 385°F. for 814 hours and at 390°F. for 774 hours. The bearings were just beginning to be noisy.

RESULTS OF OUR LIFE TESTING at 350-400°F. have been confirmed by independent investigators. We feel justified, therefore, in raising the maximum operating temperature suggested for Dow Corning 44 Silicone Grease from 350 to 400°F. Maximum speed factor (mm. bore x rpm) remains at 150,000-225,000.

ANNEALING OVENS AT 1400°F. are located only 2 feet from bearings on motor directly coupled to forced draft fans. In spite of frequent relubrication with organic greases these bearings had a service life of about 6 months. The electrical foreman finally installed bearings prelubricated with Dow Corning 44 Grease. These bearings have never been relubricated and they are still in service after about 2 years of operation.



DOW CORNING SILICONE OILS

METAL COMBINATIONS now commonly used in bearings were developed to give maximum service with conventional lubricants. They are the result of years of Edisonian research. Yet many people assume that the lubricant is incidental; expect a synthetic lubricant to perform equally well between metals carefully selected for use with petroleum oils of radically different chemical structure. That's a fallacy that may lead to trouble in the use of synthetic lubricants, including our silicone oils and greases.

RELATIVELY CONSTANT VISCOSITY over a wide temperature span, exceptional heat stability and oxidation resistance are properties peculiar to our silicone fluids. And those are among the properties required of an ideal lubricant. The ability to reduce wear and friction is the other basic property and that depends in large measure on the metal combinations. Here's some data on the relative effectiveness of various silicone fluids as lubricants for various metal combinations.

METAL COMBINATION	Dow Corning 200	Dow Corning 550	Dow Corning 710
Cast iron—bronze	Good	Good	Good
Cast iron—steel	Poor	Poor	Poor
Bronze—nylon	Good	Good	Good
Steel—aluminum	Poor	Poor	Poor
Steel—babbitt	Good	Poor	Poor
Steel—bronze	Good	Good	Poor
Steel—cadmium	Good	Good	Good
Steel—chrome	VARIA	BLE R	ESULTS
Steel—nylon	Good	Good	Good
Steel—steel	Poor	Poor	Poor
Steel—zinc	Good	Good	Good

These data were obtained with a Falex lubricant test machine under boundary or extreme pressure conditions. They are presented here only as a guide in selecting metal combinations to give maximum life with various Dow Corning Silicone Fluids. Careful breaking-in of bearing surfaces may be required.

TWO YEARS vs. 36 HOURS. That's the relative life of a few drops of Dow Corning 710 Fluid compared with any other lubricant tested in a clock motor fully exposed to the atmosphere.

DOW CORNING CORPORATION • MIDLAND, MICHIGAN

DOW CORNING SILICONES

ATLANTA • CHICAGO 1 • CLEVELAND 13 • DALLAS 1 • LOS ANGELES 15 • NEW YORK 20 • WASHINGTON 5, D. C.

CANADA: Fiberglas Canada Ltd., 1200 Bay Street, Toronto, Ontario **ENGLAND:** Midland Silicones Ltd., 49 Park Lane, London, W. 1

Published monthly by
The National Lubricating Grease Institute
Harry F. Bennetts, *Editor*
Joanne Couey, *Assistant Editor*
4638 J. C. Nichols Parkway
Kansas City 2, Mo.

1 Year Subscription $2.50
1 Year Subscription (Foreign) $3.25

The INSTITUTE Spokesman

Volume XV Number 9 December 1951

IN THIS ISSUE

ABOUT THE COVER

The cover illustration shows the High Consistency Rotational Viscometer recently developed by The Texas Company in cooperation with The Precision Scientific Company of Chicago, Illinois. Originally designed for viscosity determinations of asphalts, waterproofing compounds, and viscous paints and adhesives, the utility of the instrument has been extended to include greases and other high consistency lubricants.

By means of this Viscometer, oil refiners and grease manufacturers may measure shearing stress relations at various rates of shear to evaluate the rheological properties of high consistency greases with complex flow characteristics. Viscosity, degree of flow complexity, and relative elasticity of the product may be determined.

The instrument consists of a constant temperature bath surrounding a sample cup which may be rotated at any one of 10 controlled speeds, and a device for measuring and recording the resultant torque. A Brown ElectroniK Recorder and a Statham Strain gauge are employed. Temperature range of the bath is from 20° to 100° C, with a control sensitivity of $\pm$ 0.05° C maintained by a Rapid-Set Thermoregulator. The bath is heated by two 500-watt immersion heaters, and a cooling coil permits circulation of coolant for tests at low temperatures.

Four wells are provided in the top of the bath for bringing samples to the temperature of test while the fifth sample is being tested. All controls are conveniently placed on the front of the Viscometer; a gear-shift lever permits changing from one speed to another even while the rotor is in motion. The instrument is 66 inches high overall, 24 inches long and 20 inches wide. Water connections and a source of 115-volt, 60-cycle A.C. are required for operation.

President's page

by George E. Merkle, President, N.L.G.I.

LOYALTY FOR DEFENSE

Most, if not all, of the peoples of the earth hope and pray that we shall enjoy peace again—and soon. True, there are those who enjoy the present state of affairs throughout the world because of their own capital gains. Such people we can look upon as parasites living on the fruits of the efforts of loyal, hardworking citizens.

It is through the efforts of the loyal citizens that nations succeed and progress; and great though the progress has been in the United States, just think what it could have been if unhampered.

When I say that our progress has been hampered I am referring to the multitude of inhibitions the creative minds encounter. They can not put their full time and energy into their trades or professions. They must suffer from the actions of groups acting illegally or selfishly, to cause stoppages in production over which they have no control. This places a tremendous burden on the victims of such actions and directs their attentions away from their respective fields since their loss of work and income becomes their first concern.

Fortunately there are many who do not easily weaken and refuse to do their best because of the distressing conditions of the times. Some may call them foolish but without a goodly number of such solid citizens we would suffer more chaos than we do today.

In times of war or threatened war our Government officials and military leaders realize and recognize the importance of many so-called "Vital Industries". We can not say that anyone of the "Vital Industries" is the most important because without any one the rest might be helpless in the successful waging of war. We can however point with justifiable pride to the magnificant job that the petroleum industry has always done.

It is unfortunate that many do not know what the petroleum industry comprises. To many it is the industry producing burning oils, lubricating oils and some tars. We know only too well how inadequate this evaluation is.

There are those confronted with the many difficult problems of lubrication entirely new to the engineer. Many such problems can not be solved with the existing oils and greases. The grease industry is constantly confronted with such problems and has and still is spending a tremendous amount of effort and money to solve such problems. What is more important, they are usually solved and without much delay.

Our industry is contributing much to the Defense Effort employing top technical talent to produce the impossible, at times.

Just refer to the papers presented at N.L.G.I. meetings and see how soon you forget the "Grease Monkey", and realize that the grease industry represents "Top Technical Talent". Perhaps we should blow our horn more. We may need a more dignified word than "Grease".

analyzing —

WHEEL BEARING GREASE COMPLAINTS

D. G. Proudfoot
The Pennzoil Company

Lubricating greases are used at many points on automotive equipment, and have shown a remarkable record of proved, successful performance. An estimated 40,000,000[1] grease-lubricated vehicles on the road in this country serve as an impressive total to remind us that lubricating greases, properly applied at reasonable intervals, give reliable trouble-free service under the wide variety of speeds, loads, temperatures, and other conditions that are encountered in field service.

This paper is limited to wheel bearing lubrication and lubricants, and of the vehicles on the road, a reasonable approximation would indicate some 10,000,000 wheel-bearing grease jobs in the field each year. Obviously, some of these go wrong, and some easy estimating would turn up a figure—possibly 1,000 actual grease complaints spread over all these grease applications annually, which figure is probably a maximum.

These complaints vary greatly in form, which we shall reduce to a reasonable pattern showing in some cases what appears to have caused the trouble, as well as indicating other possible factors which are likely to cause field difficulties. In summation, the likelihood appears, that of this small proportion of complaints, only very few are attributable to the actual lubricant used.

Although the number of difficulties is numerically small, they are important because the failure or damage is readily visible to the vehicle owner and therefore becomes an immediate specific problem, calling for an explanation and remedy to satisfy what is usually an incensed customer. The other reason that these troubles are significant is that an oil company's whole grease line is evaluated, for some undetermined reason, on the performance of the wheel bearing grease item. If that is good the dealer or consumer naturally assumes the other products are equally satisfactory, or superior.

THE MYSTERIOUS BEHAVIOR OF ANTIFRICTION BEARINGS

In the analysis of the problem let us first consider the mysterious behavior of antifriction bearings in which connection two specific cases and one statement may be reported. In the discussion period of a recent section meeting of the ASLE, a well-known lubrication engineer expressed the opinion that antifriction bearings are not as reliable as sleeve bearings. His company feels that as many as 10% of the antifriction bearing installations give premature failures for no reason they have been able to find. He claims also that other lubrication men have had the same experience.[2]

The "normal" life of a bearing in automotive equipment might be expected to be the life of the car. If so, we can expect 10% of the bearings to fail without apparent cause. Most cars have eight bearings on the four wheels. Then probably half the cars that live a normal life (and many are involved in "sudden death" trips to the scrap heap) may expect one bearing failure, and this regardless of the lubricant used. Perhaps this type of explanation is involved in two interesting cases. First, 100 lbs. of No. 2 grade soda soap wheel bearing grease was opened, and suddenly "complaints" came up. Investigation by a field representative some weeks

later brought forth only vague comments from which the exact number and nature of the troubles could not be deduced. However, the salesman in the area immediately called for the return of the open quarter drum, and replacement with fresh material. But the warehouse had no fresh grease! A battle between courage and conscience ensued. Courage proved the stronger! So a 5-lb. can was filled with grease from the same quarter drum, and brought to the service man. It worked—beautifully. In fact the information was volunteered that it wasn't like the stuff that was sent back—didn't act the same, didn't even look the same!

Or another case—quarter drums of No. 3 grade soda grease, used to lubricate wheels on all kinds of automotive equipment, especially trucks. The same equipment had been used for years and personnel had not changed. After the third complaint, that particular drum was pulled out and sent to the stockroom; a fresh drum from a different batch was opened and put into service. Gradually the complaints lessened until they disappeared entirely. While this case was being investigated, weeks went by. Finally a truck was sent to pick up the old grease. It had disappeared! Investigation soon showed that the "good" quarter drum had been used up, and someone had gone to the stockroom for more. Seeing one part-drum, and knowing no reason for its being there, it was brought in and put on the line. No one had been told, and not a single complaint ever came in on the balance of the grease. So much for the mystery cases.

FOREIGN AGENTS

No—not "Reds"—just impurities. On one occasion, a pail of grease was returned. It had burned out bearings! The lab checked appearance and penetration immediately and found them to be standard. Then a run on the ASTM wheel bearing tester was made and reported. Poor, with excessive noise. The laboratory's retained sample from the same batch showed "good", with normal noise level. The grease was then dissolved, leaving a pronounced residue of metallic particles, which a magnet indicated to be iron or steel. Our best guess: the pail, with cover off or only partially on, had been kept near the shop grindstone.

One concern sent back a pail of wheelbearing grease with paper in it. We fished out some of the paper, which proved to be scraps of newspaper. Careful perusal of the scraps proved that we had want ads, and that they came from the city in which the complaint originated—some 300 miles from the plant in which the grease was produced.

There was another similar complaint in which one piece of paper was recovered—a wrapper from a candy bar. The brand was available nationwide, and also at our vending machine. On the off chance that the filling crew was responsible, the vending machine was moved to a remote area of the plant.

On another occasion, noisy wheel bearings were blamed on the lubricant. The grease in the container looked normal and batch records showed excellent. The used grease in the bearings was then dissolved, leaving a residue of several grams of steel shavings. The shavings could not come from wear in the bearings, since all surfaces were in good condition—in fact if all the shavings could have been extracted from behind the cage, the bearing might still have been usable.

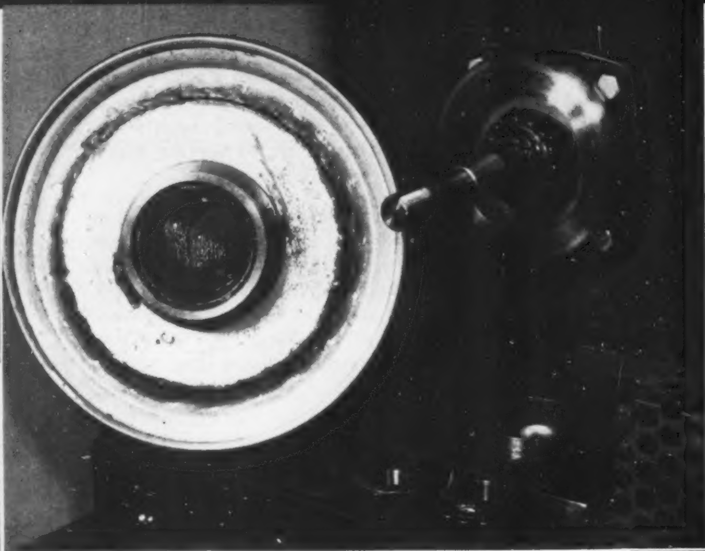
Several complaints concerned one make of car, in different areas. Since one man in our organization had bought a new car of this make, it was taken to the dealer for a replacement and regreasing of front wheel bearings—on one wheel only. Three pertinent facts were brought to light. First—the lubricant used at the factory was cup grease, which is not considered good practice. Second, the cup grease taken from the wheel was loaded with metal particles, obviously produced in the manufacture of the wheel or its components, such as the brake drums, and not removed before assembly and lubrication. Third, the cup showed etching outlining each roller. Such etching can be presumed to predispose that bearing to early failure. Strangely enough, in a year of driving, the other wheel has shown no evidence of trouble—either with the bearing or its lubricant. This again indicates that bad practice does not guarantee failure, but only increases the likelihood of failure. The actual complaint may never develop, or may show up while another lubricant is being used, at a much later date, because of weaknesses created by early conditions or misdeeds.

One quite strange case has been reported, in which large signs in a garage announce that bearings are to be kept off the floor. Whereupon one "mechanic" (the quotation marks are intentional), carefully made a neat pile of sawdust or cinders, and set his wheel bearings on the small mound, not on the floor. A similar situation prevailed in a case where the front wheels were to be balanced. The wheels were removed; bearings knocked out with a hammer and an old pipe, and picked up off the floor, set on a grease rack, and later re-installed without even a glance. Inspection was never made for possible damage due to the hammering, the fall on the concrete floor, or dirt, and there was plenty of dirt! It is the opinion of many manufacturers that 75% of all bearing failures are caused by dirt in the bearing.[14]

ANOTHER NATION HEARD FROM—CONTAMI-NATION

Used greases removed from bearings are often found to contain foreign matter other than solids. Contamination is known to be introduced from many sources, and may arise from others though we may not always identify the contaminant.

One of the easiest to identify was the case of the awful odor! Wheel bearing grease was leaking all over the brake bands! Some of the used "soupy" grease was drawn out of the hub and sent in, with unrestrained comments about odor! The smell was easily identifiable—a gear lubricant additive recommended for Hypoid and other use. Defective seals must have permitted hypoid lubricant to travel along the shaft to the wheel hub where the oil mixed with the grease, making



Here is an example of a good wheel bearing run, with good covering of the bearing and no movement of the grease in the hub or down the spindle.

With mixing of different grease types, softening has occurred, permitting shifting of grease in the hub toward the back as well as down the spindle. Incipient dripping is also indicated.

This shows very dramatically the effect of moisture, as it destroys cohesiveness. Spattering on the collector ring; almost complete movement from the bearing, down the spindle and through the back of the hub. On dismantling you see where the grease slopped out on the pan.

a soft mess which in turn leaked out onto the brake bands. Please notice—the complaint did not catch the defective seals, but only raised loud objection regarding "defective wheel bearing grease."

MIXING GREASES OF DIFFERENT SOAP TYPES

Another not-too-easy series of complaints dealt with one dealer on one make of car. He was having a considerable amount of trouble. Questioning brought out the fact that all the trouble was on new cars. The same grease, used to re-lubricate old cars, was fine. Why lubricate new cars? Because he felt the factory was using too little grease. The problem was not one of overlubrication, since the same personnel who was handling re-lubrication jobs was having no difficulty; and it claimed to be adding only enough grease to bring factory quantities up to the mechanic's usual amounts of grease. Unfortunately none of the cars involved was around, so that no samples could be taken, but the most likely explanation seemed to be—*mixing* of grease types.

At the present time, greases used on wheel bearings are made in the main from sodium, calcium, lithium, and barium soaps. Mixtures of certain soaps may be formulated to make good greases, but mixtures made at random may produce disastrous results. Thus a soda soap grease run on the ASTM wheelbearing grease tester showed a good PASS. As little as 5% of cup grease mixed in changed this to a distinct FAIL. Similarly, a lithium grease which showed PASS changed to FAIL when only 5% soda soap wheelbearing grease (also showing PASS) was mixed in.

In the case of the new cars just mentioned, the manufacturer was using calcium-base cup grease; the added grease was made from soda soap, which showed a good PASS. The mixture of these could easily have been fluid, causing it to run all over the brake bands.

On several other occasions in which we found mysterious isolated failures, the lubricant being replaced had been a factory-fill cup grease. It is suspected that these involved insufficient cleaning of the bearings, leaving enough cup grease to give a soupy mess.

CONTAMINATION FROM CLEANING

Also related to cleaning are two other possible contaminants. Most bearings are cleaned with solvent or kerosene, which is in turn blown out. Breathes there a motorist with eyes so closed that he has never seen a serviceman clean the bearings, blow them dry, and with hand still dripping with solvent, carry the "dry" bearings back to the bench, thereupon wetting them again? A very small percentage of solvent will ruin the structure of a grease, and therefore its performance.

Some cleaning is done with aqueous solutions, followed by a water rinse, then blowing with air. Some water may be left due to insufficient blowing—or, for that matter, due to wet air coming from the hose line. If all the water is not removed after such cleaning, the amount left may do its share of damage—by contamination or by rusting. From the contamination viewpoint, one percent of water changes the ASTM wheel bearing test of a grease from PASS to FAIL. One percent of the amount of grease in a wheel bearing assembly would be only a few large drops.

Speaking of water as a contaminant: water cannot be kept away from wheel bearings. Antifriction bearings have a good deal of free space.[3] As temperatures go up, air expands and the density in this space is light; as temperatures drop, air is drawn in. If the air is moist, due to humidity or to splashing, water will be brought into the bearing space. We have all driven through puddles so deep that the brakes became wet, even though they are reputed to be "sealed." If the water is as high as the spindle, can we not also expect to have water on the wheel bearings? This will mix with the grease; and the mixture will act differently than it would in the absence of water. In this connection, it is of interest that more complaints arise in humid areas than in the drier parts of the country.

The other problem associated with the presence of water is rusting. The clean surfaces of bearings from which all old grease has been removed, are quite susceptible to rusting. Aqueous cleaning is particularly hazardous from this viewpoint. However the air coming from the air hose is often wet, so that water is deposited on cleaned surfaces even after solvent cleaning. If such bearings are left around for any length of time without being greased, they may start to rust. And once the surfaces are attacked, incipient failure has set in. If clean bearings are handled, moisture and perspiration from the hands may start such rusting. Although we have never actually traced service complaints to these factors, good judgment would indicate the desirability of re-lubricating bearings immediately after cleaning[4], working the grease carefully around each ball or roller, so that all metal is coated with grease. And good judgment backed by experience shows the desirability of using a rust-preventing rather than a water-resistant grease.[5] There is no accepted laboratory measure of rust resistance in a grease; but it is known that soda soap greases and many lithium soap greases have been proved in service to be rust resistant; whereas, highly water-resistant greases should be suspect.

MECHANICAL CONDITIONS THAT PREDISPOSE BEARINGS TO FAILURES

The subject of cleaning bearings brings up another group of problems that might be called BEARINGS THAT WERE WRECKS. Here we might refer to bearings that are mechanically not in suitable condition before installation. One of the most common malpractices is spinning a bearing with air while drying. The process of "spinning" a bearing hastens drying; but unrealized, we are rotating without any lubricant, a mechanism in which both sliding friction and rolling friction are in action. The polished surfaces being dry, scratching may easily take place,[6] leading to a grease complaint at some future date.

Another often-unrecognized problem is "brinnelled" bearings.[7] It is known that so-called "false brinnelling" occurs occasionally while vehicles are transported from factory to dealer. If this is not recognized, a vehicle may be operated to failure of the bearing, and a consequent grease complaint.

Mention has been made above of possible damage to bearings during removal. Bearings are hammered or pulled out, frequently without respect for such a precision assembly; they may drop on the floor, they may be cracked, chipped, dented, or otherwise injured. They should then be cleaned and inspected before re-installation[8] in order that these or other undesirable conditions such as brinnelling, etching, or rusting, may be observed. Reassembly with such defective parts is equivalent to asking for a complaint—a grease complaint later. It has been our personal observation that the usual wheel bearing packing job does not include such inspection. Chances for failure are obvious. Note: wheel balancing and brake inspection often require removal of the wheel with attendant possibility of harming bearings or seals.

SEALS

When wheel bearings are removed, seals in many cases become impaired. Seals, like the bearings themselves, should be checked, and if badly worn or damaged should also be replaced. Grease seals are not designed to last the life of the car. It must be realized that seals supplied by the manufacturer are for reasons of economy the simplest closures that may be expected to work. One group of complaints, all centering about one make of car, seemed to point to exceptionally inadequate sealing which allowed almost unlimited access of dirt and moisture. At least the complaints ceased when the seals were changed, and only then.

Wheel bearing lubrication by softer greases would be practical if seals were better. And in most instances "leakage" complaints would disappear if seals were kept in better shape. In one case, after some 25,000 miles of operation, grease leakage was observed. The car was brought in for bearing pack and seal change. After some 250 miles, grease leakage was again observed, on the same wheel. A return to the same service man showed that no seals had been replaced. The wheel was pulled, one seal replaced, the wheel reassembled. The grease that "leaked" did not leak with a new seal. When new bearings are being installed new seals should be used and when bearings are serviced seals should always be inspected.

In one area several dealers complained about their grease being too soft. A seal expert covered the area. All the complaints then vanished. Again, this is too striking for coincidence.

IF A LITTLE IS GOOD . . .

No seals can be expected to compensate for overfilling. When a wheel bearing assembly is filled normally, a considerable space is left.[8] In service, temperature changes are inevitable; but the free space permits air to be pushed out, then drawn in. If the space is full of grease, the lubricant is pushed into the roller paths to churn, and with a temperature rise, to be pushed out of the bearings, through the seals. One dealer had several brake re-lining jobs attributable to what he called the grease melting and running out. Careful observation by a field engineer showed the mechanic to do a perfect job of handing a wheel-bearing-pack job. He greased both bearings nicely, smeared a reasonable amount of lubricant on the inside of the hub assembley, put the rear bearing on, set the wheel on gently, then just before placing the front bearing in place, got another handful of grease and jammed it into the assembly. It was the proverbial last straw.

An investigation was carried out on the ASTM grease tester, whose hub can hold about 160 g. of grease when jammed full. Using 85 g. (approximately 50% full) or 110 g. samples (approximately 70% full) many greases prove acceptable, while at the 130 g. level (approximately 80% full) some of these are thrown out. In actual operation grease so thrown, particularly against weak seals, would most likely land on the brake bands.

THE QUESTION

A legitimate question would then be — is it possible to formulate a product which is firmer, and would thus stay in place and assist the seals despite overfilling? The answer here is affirmative. But in so doing, we are subject to other criticisms.

One method of making the grease firmer is in a type of formulation that uses more soap, and is therefore more costly. Here a user whose handling of grease jobs was satisfactory is paying a premium to safeguard against the mishandling by others. A more reasonably priced formula involves normal soap content and short fibers. Here unfortunately we are faced with a peculiar correlation. A grease whose formulation gives this type of short fiber, and good wheel-bearing test runs even at 150 g. fillings (about 90% full), usually softens badly on storage. We have known of greases which in as little as 3 to 4 months, but more usually within one year, have softened from No. 3 grade to No. 2 and even No. 1 grade. This has been confirmed by the experience of others.[9]

The question may be asked—is such storage time a real problem? A check of one marketer's warehouse showed two grades of wheel bearing grease in stock, in reasonable quantity. Yet every container in stock showed a date 14 or more months after manufacture. So in making a grease which seals better, we cannot afford to neglect storage stability.

Another problem looms up in making a grease harder in order to improve its sealing ability. In the first place, we run into arguments with existing grease specifications, so that the product so made cannot be sold to many users.[10] Furthermore, we must keep in mind the temperature range involved in wheel bearing lubrication. Heavier greases are eminently suitable at summer temperatures. But the question of whether they may be too hard for satisfactory winter lubrication, seems pertinent.[11] One of our best known lubrication engineers, specializing in bearings such as are used in wheel bearings, is convinced that harder greases cause incipient

damage in the winter which will not show up until some later occasion, when the bearings are heavily loaded and hot.

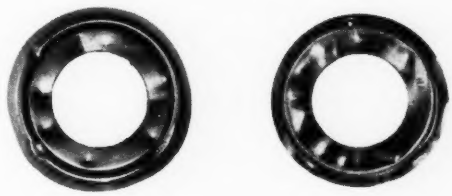
One other danger must be considered in making greases which assist seals. One charge of wheel bearing grease may be in a bearing for several years. During this time, changes are bound to take place in the lubricant. Even if it hardens only very slightly with time, the long period of use will result in ultimate excessive dryness. Yet the grease which is to help seal must be fairly firm and dry to begin with.

Despite these problems, there seems to be an established trend in this direction—toward the use of greases which run fairly dry, and thus assist seals. With due attention to the dangers involved, a reasonable compromise point may be achieved.

Certainly when soft greases are used, problems of leakage are intensified. One company found that in laboratory testing, a No. 1 grade rather than the usual No. 2 or No. 3 grade seemed adequate. They tried this product in their own fleet, with complete success, but when they released this new item to service stations and dealers in a small local area which they could watch, complaints on leakage rolled in; so, this lubricant had to be withdrawn.

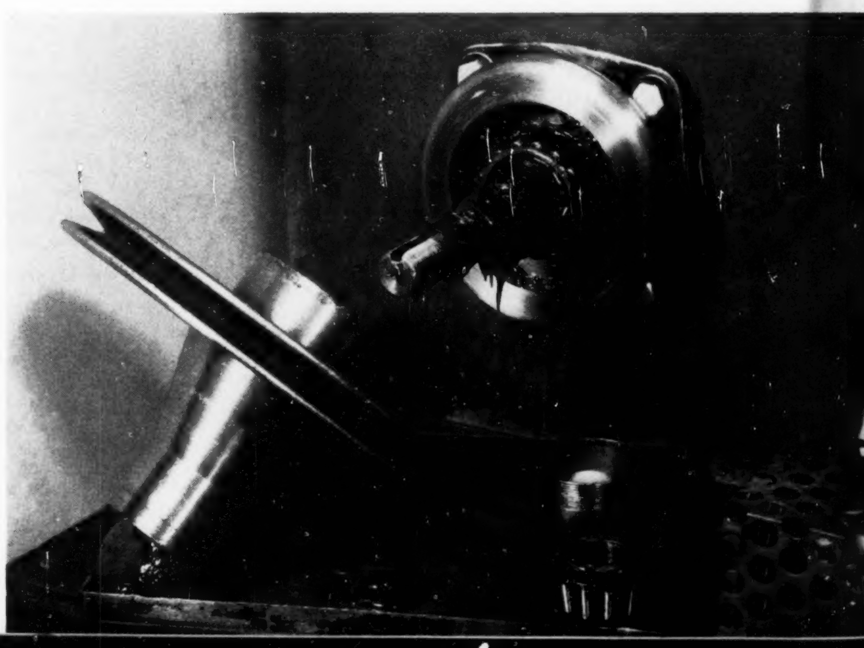
Another case along this same line is revealing. Some time ago, a formula was marketed which showed softening on aging. The proportion of leakage complaints increased progressively, and wherever the grease causing trouble was available, its penetration was found to be 30 or more points softer than when the product was made. This formula was changed to a more stable one, and leakage complaints decreased.

Examples of worn and damaged seals



Depth of shading portrays the bumps on these seals caused by the sometimes vigorous methods of dismantling. The upper left one shows a tear but otherwise is all right, even the seal tip being satisfactory.

This is the same grease as shown in the first picture where we had a perfect run. With 130 grams instead of the conventional 90, about 50 per cent overfilling, the results are well nigh disastrous.



One other peculiar fact was noted. A very large percentage of leakage complaints seems to show up near the end of a container of lubricant. This raises an interesting possibility, but one which we have never proved. Lubricating greases show some oil separation when stored. As time goes on, the amount of separated oil increases. By the time a grease is used up, several ounces of separated oil may have accumulated. Before discarding the container, the last of the grease is scraped out. If at this time the free oil is mixed in, that part of the grease will be softer, and will not perform as did the material shipped. This softer residual lubricant could easily bring in leakage complaints. Perhaps an educational program would train users to forego such false economy, thereby improving the performance record of wheel bearing lubricants.

SOMETIMES THEY GET TIGHT

Adjustment of wheel bearings must receive some consideration. Bearings that are slightly cocked, cannot track properly. Overheating and ultimate failure (blamed on grease) are then inevitable. Directions for installing bearings all emphasize this point. Some instructions call for over-tightening as an aid to proper seating of the bearings. The nut is then loosened, and readjusted properly.[12] We have however seen photographs of ball bearings showing two tracks. And as proof of unsuitable grease we have received ruined bearings which showed definite mistracking. We must thus conclude that this factor is occasionally overlooked.

The actual tightness or looseness of adjustment of a bearing is known to be a critical factor. We have seen bearings which were probably not seated when the cotter pin was inserted. Perhaps in use the bearing soon shifted into proper position, making the adjustment too loose. Such bearings seem to become even more loose with time, and are ultimately likely to cause trouble.

One automobile instruction book recommends the use of a torque wrench for the final tightening of its wheel bearings (ball bearings). The wrench involved costs about $40.00. Consequently many of the dealers do not have the proper tool; in fact, the largest dealer in a sizable city, was found not to own one, despite specific directions in the Shop Manual. Yet if misadjustment causes complaints, someone's grease will be the scapegoat.

Then we might consider the assembly plant of a large car manufacturer, which took on the assembly of a new-model commercial vehicle. The lubricant called for had to meet Army 2-108B specification, as well as the specifications of the bearing and vehicle manufacturers. Immediately trouble showed up. Some units were driven off the assembly line and had burned out bearings within 20 miles. Other units lost bearings by the time they had gone two or three thousand miles. Vehicles that got by this mileage were apparently all right. Representatives of the two bearing manufacturers, the grease manufacturer, and the automobile company checked and rechecked. One hundred per cent inspection was instituted and every precaution taken. Final conclusion—the bearings were adjusted too tight! Many thousands of dollars went into learning that simple fact. How often must this have occurred in the infinitely less-supervised conditions that prevail in the field.

A LAST FLING

One last complaint should be mentioned in this connection: leakage of grease around the hub cap caused some trouble. This resolved with the observation that the leaking lubricant was chassis grease rather than wheel bearing grease. A little checking disclosed that chassis grease was left on the nuts on the outside of the hub when the wheel was mounted, and flung off due to the rotation. Moral: Keep the wheel nuts and hub clean.[13]

CONCLUSIONS

There are many factors contributing to wheel bearing failures which are reported from the field. However, they are difficult to track down because: (1) bearings vary, so that even good practice occasionally results in failure; (2) bad practice does not always lead to failure; (3) the correct lubrication of wheel bearings is a highly technical operation involving many operations which in turn vary with the make and model of car, the type of bearings, and the position on the car—whether front or rear bearings.

A. Some failures are probably due to inherent variability in the very fine but complex mechanisms known as antifriction bearings.

B. Many failures are due to contamination of the lubricant. This contamination may be due to:

1. Foreign matter introduced by improper handling and storage of the lubricant while still in containers.
2. Foreign matter introduced during the lubrication job by mishandling of the bearings.
3. Improper cleaning.
4. Not removing all the old grease—mixtures are often bad.
5. Leaving some of the cleaning solvent.
6. Using wet or dirty air in blowing dry.
7. Water or dirt entering in service, some of it due to faulty seals.

C. Other failures are due to lack of attention to mechanical details, such as:

1. Inspection of bearings and seals before re-lubrication and re-installation, with replacement where necessary. Checking for etching, brinnelling, rusting, dents, cracks, poor surface condition, etc.
2. Spinning dry bearings.
3. Improper seating of bearings, so they do not track properly.
4. Adjustment too tight or too loose.
5. Not greasing immediately after cleaning. A clean bearing let stand too long or handled too much may corrode before it is re-coated with lubricant.

D. Many failures are due to use of excessive amounts of lubricant.

E. Some failures are due to the nature of the lubricant.

1. It should be a rust-preventive grease. Soda soap greases have this characteristic. Some, but not all, other soap bases have this trait.
2. It must not be too soft; as a corollary, it must not become soft on storage. No. 2 grade, especially at the hard end, is OK.
3. It must be hard enough to stay in place and not flow; yet, not so dry as to leave bearings unlubricated over a long period of time, or in cold weather.
4. It should have a high melting point. Wheel temperatures do not normally exceed 150°F.; but under special conditions and with certain equipment, temperatures of 260°F. and possibly higher have been observed.
5. Other characteristics such as stability to working resistance to oxidation, and maintenance of consistency even though a little water has been worked in, are probably desirable added properties.

The lubrication of wheel bearings is a technical operation, involving knowledge of the different cars and their varying requirements, and careful attention to a myriad of details, that are certain to be overlooked as long as a man does not understand their reason. Despite poor field practice, the record has been good. But lubricants, seals, bearings, and our knowledge are all now at a higher level, whereupon improved practice should lead to a still better record. It is hoped that this paper will help in pointing out that higher level which can be achieved.

In closing I wish to acknowledge the cooperation of Mr. Melville Ehrlich and Mr. Francis Sayles of American Lubricants, Inc. in the preparation of this paper.

BIBLIOGRAPHY

1. 1949; 44,120,243; Automobile Manufacturers' Association—figures from U. S. Bu. Public Roads.

2. Note—from The Timken Engineering Journal, Copyrighted 1935, pg. 16—"The life expectancy curve shown . . . is based on 3,000 hours life (with not over ten per cent failures) . . . confirms this opinion."

3. Palmgren, "Ball and Roller Bearing Engineering", 1945. Pg. 205 (referring to grease)—"Normally only about half of the free space in the housing is filled."

4. Palmgren, pg. 203—"After cleaning the bearings must not be allowed to remain dry for any length of time . . ."

5. Palmgren, pg. 208.

6. "The ABC's of Lubrication Service" by the Chek-Chart Corporation, copyright 1948, pg. 12.

7. Palmgren (above), pg. 218.

8. "Lubrication", vol. 36, No. 3. Pgs. 34-5 (March, 1950).

9. Paper—"The Effect of Soap Components on the Physical Properties of Soda-Base Greases" by J. M. Musselman, delivered before the Annual Convention of the NLGI, Oct. 31, 1950.

10. Only one of many examples—U. S. Military Specification MIL-G-2108. See also Hemmingway, Inst. Spokesman, July, 1951, pgs. 16-21.

11. Maag—"Wheel bearing Lubrication from Manufacturers' Viewpoint."

12. "Service Man's Guide to Automotive Lubrication" by Chek-Chart. Section on "Front Wheel Bearing Service and Adjustments."

13. Ford Service Letter FO-33, Item No. 2.

14. Chek-Chart Lubrication Handbook, pg. 7.

The lower center assembly has nicked rollers obviously not the result of grease, while the inner element on the right has a mechanical flaw on one rim. The race on the lower left depicts evidence of the two tracks, caused by misalignment in assembling. The top center bearing looks normal to casual inspection and might be regreased and reinstalled. When completely disassembled the inner surface showed abrasion caused by fatigue or shock, or a combination of both, that would ultimately come to look like this one on the right and conceivably someone would have a grease complaint.

DISCUSSION OF

analyzing—WHEEL BEARING GREASE COMPLAINTS

by H. L. HEMINGWAY
The Pure Oil Company

It is gratifying to see increasing light shed on the often troublesome problem of wheel bearing grease performance. Perhaps, in the handling of complaints, it is a natural tendency to be stampeded into a short range, emergency treatment without ever subjecting the problem to a careful, long range analysis. Dave Proudfoot has helped us all by ably reporting his own observations on wheel bearing grease performance.

Mr. Proudfoot placed some emphasis on the experience common to many of us in which replacing the container of grease that the customer complained about with a fresh container, apparently cured the trouble—even though the fresh container contained the same product. This is a general technique which is occasionally used in the handling of a complaint, and it frequently works, but it does have the disadvantage of tacitly admitting that the grease might have been at fault.

In an article which appeared in the July, 1951 issue of the *Institute Spokesman*, I attempted to point out why wheel bearing lubrication is so troublesome and complex and why, relatively all of us seem to have more complaints per pound of this product than on any other lubricant. First, of course, is the rather confusing range of recommendations made by vehicle and bearing manufacturers, alike, to cover the lubrication of apparatus which is practically identical in all automotive vehicles. Manufacturers recommend lubrication at intervals ranging from 5,000 miles to "never," recommend various quantities of grease from just a thin film on the bearings, themselves, up to packing the hub and cap three-fourths full. Some manufacturers recommend fibrous type grease, while others do not; NLGI consistencies of No. 1, 2 and 3 are recommended. One manufacturer says bearing discoloration is harmless, while another recommends throwing discolored bearings away.

In addition, in front wheel bearing lubrication more than in any other automotive lubrication service, the skill of the individual doing the work plays a most important part. Mr. Proudfoot devotes considerable space to this point. I have tried to estimate the relative importance of skill and the quality of the lubricant in Figure 1. You may not agree with the absolute values shown for the relative importance of skill

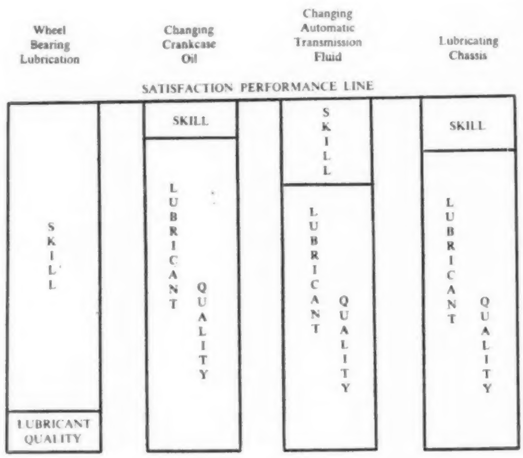
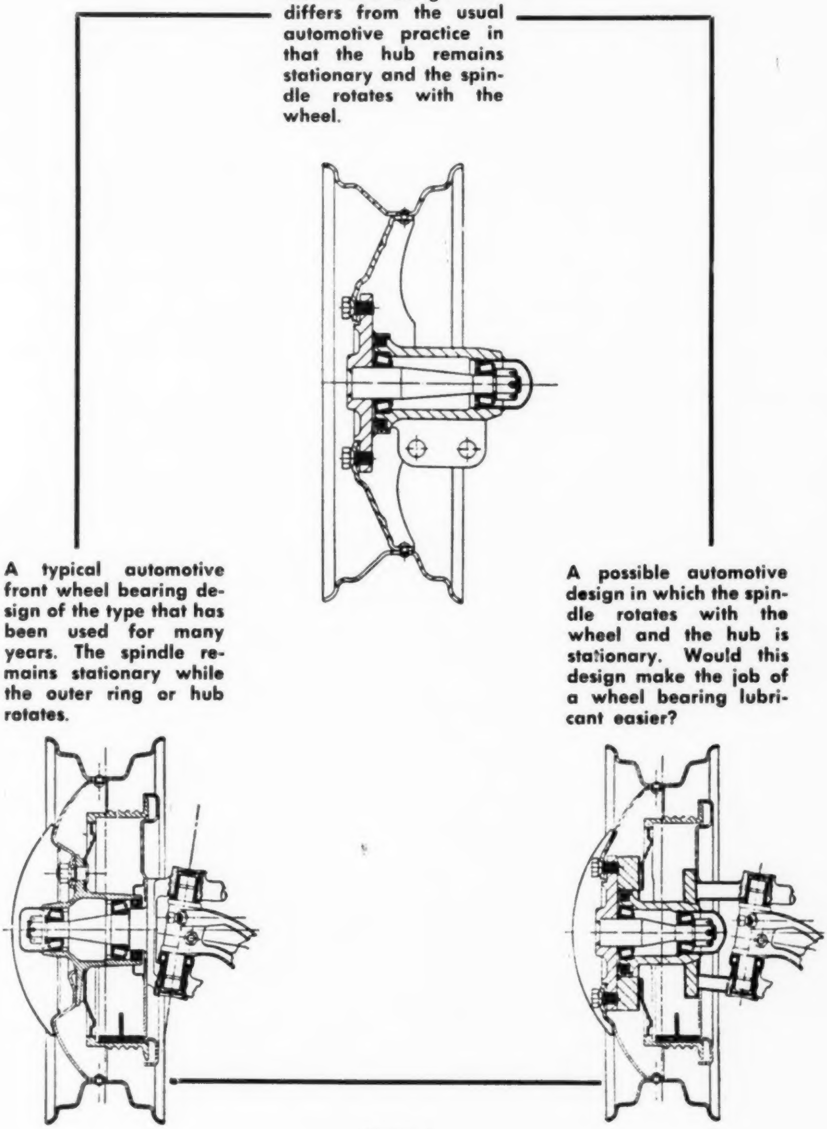


FIGURE 1

and lubricant quality, but if you analyze each job, I think you will agree that the values shown are in the right order.

Finally, of course, is the question of design. Front wheel bearing lubrication troubles really started when the same old design was further complicated by marriage with the front wheel brake. Or, perhaps, judging by the troubles that this union has bred, there is reasonable doubt that a properly supervised wedding ever took place.

In most such cases where anti-friction bearings are used, we are dealing with a rotating spindle and a fixed outer race or hub. It has been suggested that rotating spindle mechanisms are more favorable to grease life. Figure 2 shows various types of front wheel bearing design setups. Perhaps by one of these, or other modifications of design, our clever friends in the automotive industry could somewhat ease the troublesome problem of front wheel bearing lubrication.



A wheel bearing design used on a farm implement. The design here differs from the usual automotive practice in that the hub remains stationary and the spindle rotates with the wheel.

A typical automotive front wheel bearing design of the type that has been used for many years. The spindle remains stationary while the outer ring or hub rotates.

A possible automotive design in which the spindle rotates with the wheel and the hub is stationary. Would this design make the job of a wheel bearing lubricant easier?

Figure 2

The Composition of

FATS

THE general scope of the problem of investigating the chemical constituents of the natural fats is now clear since it has been conclusively demonstrated that seed fats are mixtures of mixed triglycerides and that the occurrence of simple triglycerides is quite exceptional. It falls into two parts: 1. the identification and determination of the proportion of the fatty acids present, and 2. the elucidation of the manner in which these are combined with glycerol.

At the present time the methods of that branch of analysis concerned with the determination of the fatty acid composition of fats and oils have attained an advanced state of sensitivity and precision; contributions to the evolution of the present day techniques have come from a number of sources, and the techniques themselves embrace a wide variety of separation procedures and analytical methods directly applicable to fatty acid mixtures.

Non-Solvent Crystallization. The higher melting fatty acids of a fatty acid mixture have been separated from the mixture by slowly chilling and filtering out the solidified portion.

Solvent Crystalization. a) *Separation of Fatty Acid Salts.* The separation of fatty acids from solid fatty acids through the difference in solubility of such salts as barium, magnesium, or lead salts was first accomplished nearly a century ago. Such methods are tedious and only successful to a limited extent. In all cases the methods are empirical, and a single fractionation yields only a partial separation, a number of operations being required for a good resolution.

b) *Separation of Fatty Acid Bromine Addition Products.* Bromination of linoleic acid yields, among other products, a solid tetrabromide insoluble in petroleum ether, and linolenic acid, a hexabromide insoluble in ether. These facts have led to procedures for the separation of these acids from mixtures, but the large percentage of other isomers formed and the complex mutual solubility effects largely vitiates these procedures.

c) *Separation of Fatty Acids.* Crystallization procedures at or near room temperature are not well adapted to separating most mixtures of fatty acids, for above 0°C. the common unsaturated fatty acids are liquids, infinitely soluble in such solvents as acetone and ether. Only in the comparatively recent past have crystallization techniques, at markedly lower temperatures, been employed. Low temperature solvent crystallization has been extensively used for the isolation of many naturally occurring fatty acids such as oleic, linoleic, linolenic, erucic, and ricinoleic. Elaborations of the procedure have served as foundations of analytical methods for the determination of the saturated acid content of fatty acid mixtures. Determinations of fatty acid solubilities and of mutual solubility effects at low temperatures are leading to the development of more effective crystallization procedures.

Fractional Distillation. The first important studies in the use of fractional distillation for the separation of fatty acids were made as early as 1880. The fractional distillation of methyl or ethyl esters of the acids has been considerably re-

by B. F. DAUBERT

Department of Chemistry

University of Pittsburgh

This is Mr. Daubert's second article on Fats. His first, "The Chemistry of Fats," appeared in the November issue of **The Institute Spokesman.**

"The Composition of Fats" is reprinted here through the courtesy of **The Journal of The American Oil Chemists' Society**, October, 1949 issue.

fined since that time by a large number of investigators. For accurate quantitative results it is necessary to obtain separate portions which contain not more than two adjacent homologous saturated esters and not more than two adjacent homologous unsaturated esters. For the latter fraction the percentage of saturated esters can be determined by oxidation of the unsaturated esters to alkali-soluble products. The saponification equivalent and iodine value of the original and the separated group together with the percentage of the latter provide enough data for calculating the composition of the total fraction in terms of knows fatty acids. Four equations are obtained, sufficient to provide a solution for four unknowns.

In practice the procedure is usually, but not always, simplified by preliminary separation of the mixed fatty acids into saturated and unsaturated. In these cases where myristic and lower fatty acids are present, it is often possible to separate these by a preliminary partial ester distillation. Whenever lower fatty acids are present, e.g. butyric, a preliminary steam distillation of the mixed acids serves to remove them for separate examination.

Chromatography. Chromatographic separations, originally developed at the beginning of the 20th century, have only recently been successfully applied to the separation of fatty acids. Unsaturated fatty acids, saturated fatty acids, and branched chain fatty acids, have been separated, using a flowing chromatographic method. Partiton chromatography has been recently applied to the separation of normal saturated fatty acids from five to 19 carbon atoms.

Spectrophotometry. Studies of the ultraviolet absorption spectra of unsaturated fatty acids, both of the natural isomers and the conjugated isomers, have led to the development of methods for the direct determination of tetraenoic, trienoic, and dienoic acids in a fatty acid mixture. Determination of the iodine value of the mixture allows an extension of the method to the estimation of monenoic and saturated fatty acids.

In many instances, several or more of the above procedures have been used in combination to great advantage in the isolation of a single acid or the identification of the components of a mixture. The analytical work of Hilditch exemplifies a combination of the lead salt separation and fractional distillation; his extensive studies of the fatty acid compositions of many plants and animal fats have established correlations between fatty acid composition and species. The quantitative work of Baldwin and Longenecker clearly demonstrated the remarkable accuracy attainable in the analysis of a fatty acid mixture and its components by a combination of spectrophotometry and fractional distillation.

Glyceride Content of Fats. The analytical methods previously described have been widely applied, and the fatty acid compositions of many naturally occurring fats and glyceride oils are known; many properties of these substances can be successfully correlated with their fatty acid composi-

tions. But this approach to the properties of fats and oils from the viewpoint of their fatty acid composition, although a valuable one in many respects, encounters its final limitations in the facts that the components of these materials are glycerides rather than fatty acids and that the characteristics of fats and oils are derived from the characteristics of the component glycerides.

It is apparent that the order of magnitude of difficulty attending the separation and determination of glycerides is much greater than that concomitant to the separation and determination of fatty acids. Adjacent members in homologous or analogous series of glycerides differ from each other much less in characteristic physical and chemical properties than do adjacent members of similar series of fatty acids because of the factor of approximately three separating their molecular weights. Furthermore many of the procedures proper to fatty acid analyses cannot be applied to glyceride analysis because they possess features which would lead to the destruction of the glycerides. Prominent examples of unapplicable procedures are salt formation and fractional distillation in the range of ordinary vacua, the one involving glyceride destruction through hydrolysis, the other through polymerization and thermal cracking. Only since 1927 has the study of the component glycerides of fats and oils been placed on a quantitative basis. Since then a number of separations and analytical procedures have been developed and applied. They lead for the most part to the elaboration of glyceride mixtures simpler than the original or to analytical figures in terms of closely related glycerides, and in only a few cases have single compounds been separated or analytical data in terms of single compounds been obtained. However the occurrence in various fats of simple triglycerides —trilaurin, trimyristin, tripalmitin, triolein, trilinolein, trilinolenin, trierucin, triricinolein, trielaeostearin, and traces of tristearin—have been authenticated. Of the mixed triglycerides only the 2-oleyldistearin, of kokum butter, cocao butter, and the rare allanblackia fats and 2-oleyldipalmitin of Stillingia tallow and piquia fats have been authenticated. There is also considerable evidence that 2-palmityl oleylstearin is contained in lard.

One of the first quantitative tools applied to glyceride analysis was the oxidation procedure developed by Hilditch. It allows the estimation of those glycerides possessing only saturated acids. The glyceride mixture is oxidized in acetone with potassium permanganate; all ethylenic leakages are split and the carbons oxidized to carboxyl groups. The alkali soluble azelaoglycerides can be separated from the unaffected trisaturated glycerides.

Complete and partial hydrogenation procedures are also used to study the glyceride composition. In general, however,

the exact sequence of events in the hydrogenation of a complex mixture of glycerides of different degrees of unsaturation is not known. Thus the margin of error in both types of hydrogenation studies is rather large, and they are not favored for analytical purposes at the present time. Hilditch says, ". . . (hydrogenation) is a procedure which should be used with caution and indeed avoided where possible. It has proved of considerable use in the earlier stages of the study of glyceride composition, but the subsequent advances in pre-resolution of mixed glycerides by crystallization have made its employment less necessary."

Molecular distillation has been applied to many oils but the process, while capable of separating free fatty acids, odorous and flavoring materials, sterols, and vitamins from the oils, does not accomplish any significant fractionation of the glycerides. The predominance of oleodilinolenin and dilinoleolinolenin in linseed oil has been established by chromatography. In addition an impure trilinolenin has been isolated from linseed oil by the same technique.

Solvent Partition. The employment of binary liquid-liquid extraction systems for the separation of components of oils has been tried; high iodine value fractions have been separated from soybean, corn, cottonseed, and linseed oils using the system oil-methanol. The only slight solubility differences exhibited between the predominant glycerides of these oils and the complex mutual solubility effects found to exist impose limitations on this type of separation as far as isolation of single glycerides or even radically simpler mixtures is concerned.

Non-solvent crystallization is not very useful for glyceride separation. On the other hand solvent crystallization for the separation. of unchanged glycerides has been of advantage and falls naturally into two phases. Prior to 1936 the primary aim was the isolation of pure glycerides from fats and oils with little attention being focussed on the evaluation of the entire glyceride structure of a particular fat as a whole; these studies were conducted in the range of temperature from 0° to room temperature. In 1936 however crystallization procedures were applied not towards isolating single compounds but rather toward separating the entire complex fat into a number of fractions simpler in their composition; chemical studies for further information could then be applied to the individual fractions, the relative simplicity of the fractions facilitating the interpretation of the chemical data. The method has been applied to a number of fats employing temperatures below 0°C. This technique of low temperature precipitation of the glyceride components of an oil from a dilute solution of the oil or fat, utilizing no physical agencies that would change the glyceride components of the oil, involving no chemical treatment of the glycerides, and possessing the ability to bring about a marked separation of the glycerides, is the most promising procedure yet developed for the resolution of a glyceride mixture into its components or markedly simpler mixtures.

This brings us to the glycerides themselves. The fat or oil triglyceride mixture may be regarded as broken down into glyceryl residues and fatty acid residues, and an inquiry has been instituted to determine what scheme of fatty acid distribution predicts the manner in which the fatty acid residues are actually found distributed among the positions on the glyceryl residues available for esterification. The inquiry possesses additional interest in that all features of

TABLE I

Comparison of Experimental With Calculated Glyceride Structures

	-Ln -Ln -Ln,1	-Lo -Lo -Lo,1	-O1 -O1 -O1,1	-S -S -S,1	-Ln -Ln -S,2	-Ln -Ln -O1,2	-Ln -Ln -Lo,2	-Lo -Lo -S,2	-Lo -Lo -O1,2	-Lo -Lo -Ln,2
Mono-Acid Triglyc. Distribution	6.15 g.	596	230	147	0	0	0	0	0	0
Random Distribution	0.0003	223	12.5	3.24	0.02	0.03	0.07	164	257	6.96
Even Distribution	0	0	0	0	0	0	0	291	524	0
Partial Random Distribution	0	8.0	0	0	0	0	0	332	485	0.50
Experimental Distribution	0	8.9	0	0	0	0	0	335	482	0

	-O1 -O1 -S,2	-O1 -O1 -Lo,2	-O1 -O1 -Ln,2	-S -S -O1,2	-S -S -Lo,2	-S -S -Ln,2	-S -O1 -Lo,3	-O1 -Lo -Ln,3	-S -O1 -Ln,3	-S -Lo -Ln,3
Mono-Acid Triglyc. Distribution	0	0	0	0	0	0	0	0	0	0
Random Distribution	23.9	98.0	1.02	15.3	39.9	0.41	125	5.34	1.30	3.40
Even Distribution	0	0	0	0	0	0	146	15.5	0	3.00
Partial Random Distribution	1.69	70.0	0.50	4.16	17.5	3.20	40.8	1.00	10.5	2.94
Experimental Distribution	3.60	72.7	0	0.18	16.8	4.10	41.5	0	11.8	3.19

the distribution scheme actually found must be paralleled by features in the enzyme systems responsible for the glyceride synthesis.

The number of glyceride types possible from n fatty acids depends on the degree of distinction made.

Let

N_1 = number of glycerides, optical isomers distinguished $= n^3$

N_2 = number of glycerides, position isomers distinguished, but not optical isomers $= (n^3 + n^2)/2$

N = number of glycerides, neither position nor optical isomers distinguished $= (n^3 + 3n^2 + 2n)/6$

Schemes of Fatty Acid Distribution. The oldest scheme, the monacid triglyceride scheme, long proven invalid and of interest only historically, is the simplest possible and states that only monacid triglycerides are formed; thus all palmitic acid in a fat would be esterified as tripalmitin. Here the quantitative calculations are obvious. All experimental work on both plant and animal fats indicates this idea to be in error; the reality is nearly the reverse since experiment demonstrates simple monacid triglycerides formation to be the exception rather than the rule.

Random Distribution. The scheme of random distribution states that the fatty acids are distributed among the various positions of the glycerol molecule in the manner that would be expected from considerations of probability alone; simple continuous relationships exist between the number of glycerides present and between fatty acid concentrations and glyceride concentrations. Hence an oil or fat in which the fatty acids are distributed randomly possesses quantities of all possible triglycerides derivable from the fatty acids present.

The total possible chemically distinguishable glycerides = possible triacid triglycerides + possible diacid triglycerides ($\alpha = \alpha'$) + possible diacid triglycerides ($\alpha = \beta$) + possible monacid triglycerides $= (n^3 + n^2)/2$. For example, two fatty acid species result in an oil containing six glyceride species while an oil containing four fatty acid species results in an oil containing 40 glyceride species. The random scheme results in a more complex fat than does any other scheme.

Even Distribution. The scheme of even distribution arose from the experimental observation that monacid triglycerides in natural fats and oils are actually rather rare. Both previously mentioned schemes of distribution allow the occurrence of monacid triglycerides; the random scheme, in fact, indicates that a fatty acid existing in a large percentage is represented to a substantial degree by a monacid triglyceride forma-

tion and that even an acid existing in only a small percentage is present in some amount as monacid triglyceride. The even distribution hypothesis limits the types of glycerides possible. Every glyceride molecule must possess one molecule of the particular fatty acid before any glyceride can possess two, and every glyceride must possess two before any glyceride can possess three. Geometrical considerations of the even case show that a concentration greater than $33\frac{1}{3}\%$ is necessary for diacid glyceride formation and that a concentration greater than $66\frac{2}{3}\%$ is necessary for monacid glyceride formation. In even distribution not all conceivable glycerides are expected. Even distribution, as may be seen, greatly reduces the number of total glycerides.

It should be emphasized that the even system, though evolved primarily from considerations of monacid triglycerides, affects the proportion of all types of glycerides existing in a fat and give a composition entirely different from that of the random scheme.

Partial Random Distribution. The partial random scheme represents something of a compromise from the relatively rigid conditions of the pure even system and derives from the fact that monacid triglycerides, although much less prevalent than the random system suggests, occur more frequently than the pure even system allows. The partial random system, in effect, has many characteristics in common with the even system, but it deviates from the even system in that it decreases the critical concentrations of acid required for diacid and monacid triglycerides formation from $33\frac{1}{3}\%$ and $66\frac{2}{3}\%$ to lower values. Obviously many partial random systems exist. The minimum fatty acid concentration for monacid triglyceride formation in the partial random scheme has been set as low as 50 to 55%, with a corresponding reduction made in the requirement for diacid triglyceride formation. The partial random scheme as used in a recent study of corn oil placed the critical fatty acid concentration necessary for monacid triglyceride formation below 59.0% and above 20.9% and the concentration necessary for diacid triglyceride formation below 20.9% but above 0.56%. Hence linoleic acid (59.6%) can occur either once or twice, or three times. Oleic acid (23.0%) can occur either once or twice and the same is true of saturated acid (14.7%). Linolenic acid (0.6%) can occur only once.

In Table I is shown a comparison of glyceride structures for corn oil calculated for the above schemes and determined by analyses of fractions obtained by low temperature fractional crystallization of the oil in acetone.

Mechanism of Glyceride Formation. It is reasonable to assume that glycerides are largely formed from carbohydrates. This is suggested by the sharp decline of carbohydrates and the rise of the glyceride content in ripening seeds.

BOOKS AND PUBLICATIONS . . . about the industry

PHYSICAL CHEMISTRY OF LUBRICATING OILS

By A. Bondi, Shell Development Co., Emeryville, Calif. 450 pages. Published 1951. $10.00.

This volume gives you the latest theories on lubricating oils and the physical and chemical principles underlying their action. It is a broad and well documented treatment of specific problems in lubricant technology. Many inaccessible or widely scattered data and simple methods for the estimation of unknown properties from few given data will prove most valuable to engineers, physical chemists and all technical men in the lubrication field.

The author is an outstanding authority who has been working for many years with practical lubrication problems in the laboratory. He began writing papers on the physiochemical behavior of lubricants in 1936. This long experience, plus the author's endless quest for background information on lubrication problems, forms the basis for this useful book. It should contribute greatly to the solution of many basic problems that are still unsolved, particularly in wartime operation of airplanes and automotive equipment. Such properties as viscosity, pour point, oiliness, flowing characteristics, foaming, etc. are discussed in great detail and attention is given to additives of all types. An entire chapter is devoted to synthetic lubricants and there is an especially valuable section dealing with the reaction kinetics involved in lubrication problems.

This book makes an excellent companion to "Motor Oils and Engine Lubrication" by Carl Georgi published in 1950. The two books now constitute a thorough presentation of the latest information available on the theoretical and highly practical aspects of lubrication.

MOTOR OILS AND ENGINE LUBRICATION

By Carl W. Georgi, Technical Director, Research Laboratories, Quaker State Oil Refining Corp., Vice-President, Enterprise Oil Co., Inc. 515 pages. Profusely illustrated. Numerous tables and charts. Published 1950. $8.50.

The practical problems of engine usage, maintenance and lubrication, as well as causes and remedies affecting operating troubles, are described in this comprehensive book. It is the first of its kind to assemble for ready reference detailed information on the properties and service behavior of motor oils.

It covers at length the methods of testing and evaluating performance characteristics of motor oils. Particular emphasis is laid upon viscosity index and its importance in all phases of motor lubrication. An unusual feature of the book is the inclusion of detailed specifications covering various types of engine tests, properties of lubricants (ash, carbon residue, pour point, color, corrosion, flash point, etc.) and all types of performance ratings. Also included are chapters devoted to the refining and manufacture of motor oils and descriptions of their chemical and physical properties. Later sections of the book deal with the application of motor oils and the relation of oils and lubrication to engine design, operation, maintenance, breakdowns and failures. The subject matter is arranged to permit ready reference to many types and varieties of engine failures and operating difficulties.

together with causes and remedies. Valuable information is given to aid in diagnosing engine ailments, and in adopting corrective steps necessary to prevent their recurrence.

The text has purposely been written in practical terms and avoids as much as possible highly involved technical considerations. Illustrations are used freely, especially those relating to engine wear. The book has been designed and written primarily as a reference work for lubrication engineers, automotive service engineers, oil salesmen, engine designers, fleet maintenance superintendents, field service engineers, technical service and sales service departments of oil companies and employees in oil laboratories.

"AT YOUR ELBOW"... the most complete Stearate Service in the nation

Nothing is so important, in these days of specialized lubrication, as choosing the right base for a given oil, and using it most effectively—facts which make Metasap* Service invaluable to the lubricant manufacturer. For Metasap is not only an experienced producer of grease-making soaps, but is ready at all times to provide expert assistance to help solve any grease production problem.

And we put Metasap Service right "at your elbow." Our representatives in 44 States and 11 warehouses across the nation, backed by Metasap's volume production, are prepared to serve you whenever you telephone, wire or write; our Technical Service Division is prepared to make recommendations based on your particular needs, and the facilities of our modern laboratories are at your disposal.

You'll find Metasap Service and Metasap Metallic Soaps unequalled for meeting any grease specification.

Metasap Aluminum Stearates, today's foremost contribution to grease-making, afford a versatile means for varying the properties of finished greases. They include:

METASAP 537—*a "body builder" that gives No. 3 consistency and a short feather to the finished product.*

METASAP 598—*an extremely high-gel -strength base.*

METASAP ALUMINUM STEARATE GM—*for producing softer, stable greases with low-viscosity oils.*

METAVIS* 540—*for producing low-viscosity, adhesive type greases.*

*Reg. U. S. Pat. Off.

METASAP CHEMICAL COMPANY, Harrison, New Jersey

Branches: CHICAGO • BOSTON • CEDARTOWN, GA. • RICHMOND, CALIF.

Stocks at: Cleveland, Ohio; Louisville, Ky.; San Francisco & Los Angeles, Cal.; Portland, Ore.; Spokane and Seattle, Wash.

METASAP CHEMICAL COMPANY *REG. U. S. PAT. OFF.

Stearates

of Calcium • Aluminum • Lead • Magnesium • Zinc

PEOPLE in Your Industry

H. C. Meyer, Jr.

NEW CHEMICAL SALES MANAGER FOR FOOTE CHEMICAL COMPANY

H. C. Meyer, Jr. has been made Manager of Chemical Sales for Foote Mineral Company, covering a territory throughout the U. S. on chemicals, petroleum products, and allied fields. Meyer joined Foote in 1940, serving first in their chemical plant and later took charge of research on lithium base greases. In this latter capacity he was instrumental in developing and merchandising lithium hydroxide for use in multi-purpose greases. Foote is licensee for the Earle patents covering production of lithium greases in the domestic and foreign markets. There are currently 27 major U. S. oil companies now licensed to produce multi-purpose lithium greases.

LUBRICATE
FOR SAFETY
EVERY 1,000 MILES

Consumers Ask for Simpler Lubrication Requirements

—says Ray Shaw

One-hundred-per-cent rugged individualism may be desirable in staying alive on a deserted island, but not in making truck and bus lubrication recommendations, Ray Shaw, President of THE CHEK-CHART CORPORATION, told the Society of Automotive Engineers.

Speaking before the SAE National Transportation Meeting at the Hotel Knickerbocker, Shaw said the best kind of individualism "contributes to the well-being of the society in which it exists." He praised the contributions made to the growth of the nation by both manufacturers and operators of the country's eight million trucks, buses, and motor coaches. These vehicles, said Shaw, were sold on the basis of benefits to the owner: low operating cost, adequate power, low-cost maintenance, and so on. Thus, he asserted, "even though each manufacturer is ruggedly individualistic in vehicle design, he tempers that individualism by what he knows the customer wants."

One thing the customer wants, continued Shaw, is more simplified and more uniform information on lubrication. He based his observation on what CHEK-CHART has learned from both truck fleet operators and truck service men in service stations and garages. These men, he asserted, realize that manufacturers' recommendations are best, but when several makes of vehicles are involved, the variations in these recommendations prompt them to compromise. He cited the cases of several large fleet operators who, in evolving practical maintenance programs, have had to compromise with the vehicle manufacturers' lubrication recommendations.

Thus, claimed Shaw, the individualism in design that benefits the customer comes close to the "deserted island" brand when manufacturers' lubrication recommendations are viewed collectively. Illustrating his points with detailed analyses prepared by CHEK-CHART's Engineering Department, Shaw pointed out the large number of variations that exist.

For example, to follow the recommendations of 19 truck manufacturers and 14 bus and coach manufacturers on engine oil alone, the service man would need 25 different types and grades! Obviously, even the matter of storage space for all these containers at one service point would itself present a difficult problem.

Essentially the same situation exists regarding gear lubricants. Transmission and differential gear lubricants required by truck, bus, and coach manufacturers cover fifteen different grades of eight types. Besides these are the many special-purpose lubricants specified by manufacturers for various uses — 28 different lubricants.

The total of all these different lubricants is 39 different types and 40 different grades—a total that no one fleet operator or service station could possibly stock. This great variety of lubricants needed, said Shaw, is what prompts fleet maintenance managers and service men to seek and find compromise solutions. Just as these practical men have found them, he asserted, it should be possible

for manufacturers to find areas of compromise that will lead to a smaller variety of different lubricants required.

Lubricant recommendations are only one phase of the problem explored by CHEK-CHART's engineers, Shaw pointed out. One-hundred-per-cent rugged individualism is present also in manufacturers' recommended service intervals. For example, in comparing recommendations of the 33 manufacturers for crankcase drain and refill intervals, 14 different recommendations are given, ranging from "Every 1,000 miles" to "When oil becomes thin or dirty," or "Consult oil company engineer."

Similarly, there are 13 individual recommendations given for transmission drain and refill intervals, and 11 for differential drain and refill. On carburetor air cleaner service, manufacturers specify 12 different intervals.

It is obvious, Shaw conceded, that some differences in recommendations are needed to cover all vehicles from the smallest to the largest. However, it is the excessive number of variances that has caused fleet operators and truck, bus and coach service men to create their own compromise recommendations.

It has already been proven possible, Shaw stated, to achieve a reasonable degree of uniformity in the matter of temperature ranges for specifying SAE grades of oil. As published by the 33 manufacturers of trucks, buses, and coaches, the temperature ranges for crankcase oils totaled 24, those for transmissions 14, and for differential lubricants, 16 different ranges.

However, these same 33 manufacturers, in approving temperature ranges for use in CHEK-CHART publications, have achieved complete uniformity in the temperature range for specifying crankcase oil! For transmission and differential lubricants, the number of temperature ranges has been successfully limited to four each!

This high degree of co-operation is gratifying proof, said Shaw, that there is a chance for simplification in specifying lubricants and service intervals as well. In the passenger car field, such simplification has been going on for several years, and although there is still much to be accomplished, there are definite signs of progress. Many of the top-level technical men have shown a decided willingness to work toward uniformity without sacrifice of safety.

The SAE National Transportation group, Shaw stated, is in an admirable position to begin the simplification of manufacturers' recommendations for trucks, buses, and motor coaches, through discussion and debate. This co-operative effort will bring constructive results at the service level. Manufacturers will be able to know that their recommendations will be followed—that their vehicles will get proper lubrication. "By working toward simplification," Shaw concluded, "manufacturers will be serving the best interests of their customers in the best tradition of American individualism."

Following Shaw's speech, six executives of oil and automotive companies acted as discussors on the subject. They were: E. F. Collins, GMC Truck & Coach Div.; E. L. Fortier, International Harvester Co.; Howard Hill, Shell Oil Company; K. L. Hollister, The Texas Company; J. L. McCloud, Ford Motor Co.; and J. M. Miller, Standard Oil Company.

Along a similar line, Ludlow Clayden, of Sun Oil Co., discussed the need for uniformity in servicing of items other than lubrication. Chairman of the session was F. E. Sandberg, Ford Motor Company, of the SAE Truck and Bus Activity Meetings Committee.

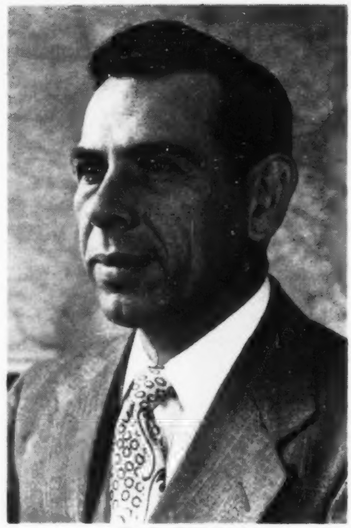
L. L. Meikle

L. L. MEIKLE ELECTED HEAD OF LINCOLN ENGINEERING COMPANY

Lincoln Engineering Co., St. Louis, manufacturers of equipment for the application of lubricants, announces the election of Mr. L. L. Meikle as President of the Lincoln Engineering Company of California.

As President of the California Corporation, Mr. Meikle will actively supervise the entire West Coast Division, comprising the states of Arizona, California, Nevada, Oregon, Washington and Western Idaho. Mr. Meikle joined Lincoln of California in 1939 and has been General Manager since 1941. He succeeds Mr. C. Homer Redd whose experience and knowledge will continue to be utilized by the St. Louis and California corporations in an advisory capacity.

FOOTE GIVES CONROY NEW RESPONSIBILITY



C. J. Conroy

Charles J. Conroy has been named Manager, Sales Coordination and Export Manager for Foote Mineral Company. Conroy served with Carpenter Steel Company in Reading, Pa. as a steel analyst from 1935 to 1937, then joined Foote's chemical staff at its old Falls Plant. In 1942 he became Chief Chemist at the company's new Exton, Pa. plant, a position he held until named Sales Coordinator in 1946. His new function carries the responsibility of coordinating all domestic sales and directing all export activity.

LUBRICATE FOR SAFETY EVERY 1,000 MILES

Your Industry NEWS

NEW PRODUCT AVAILABLE FOR EXPERIMENTS

Emery Industries, Inc., announces the availability of a new Development Product, Emery C-842-R Stearone, in experimental quantities. It is a white, crystalline solid, with a melting point of approximately 75°C. It is insoluble in water and only slightly soluble in hot alcohol or ether.

A 35 carbon atom straight chain ketone, it is represented by the following structural formula:

$$CH_3 - (CH_2)_{16} - \overset{\overset{\large O}{\|}}{C} - (CH_2)_{16} - CH_3$$

The wax like character of Stearone suggests its use as a wax or wax extender.

A descriptive bulletin and an experimental sample are available on request.

FOOTE INCREASES LITHIUM CONTROLS

Foote Mineral Company has exercised its option to buy the plant and holdings of Solvay Process Division of Allied Chemical and Dye Corporation at Kings Mountain, North Carolina. This new acquisition, plus land already owned by Foote, gives the 75-year-old mineral company control of the largest known source of lithium-bearing ores in the western hemisphere. The tract covers 881 acres, includes a complete processing plant, graded access ways and first class water supply. Price: $350,000.

Initial efforts at Foote's new operation, which has been underway for several months are concentrated on the recovery of spodumene. However, plans are already past the blue-print stage for considerable expansion which will lead to the recovery of other ores such as tin, feldspar and mica.

By December 1, 1951 it is expected that Foote's new activity will be in high gear. Much of the increasing volume of lithium ores will be processed "on location" with the balance being shipped to the company's plant at Exton, Pennsylvania.

Ernest G. Enck (seated right), Secretary and Director of Purchases of Foote Mineral Company, signs the final papers effecting the purchase of Solvay Process Division of Allied Chemical and Dye Corporation's holdings at Kings Mountain. Seated next to Enck is F. W. Alexander, President of the Union Trust Company, Shelby, North Carolina (seat of Cleveland County which includes Kings Mountain). Looking on (standing, left to right) are: Jesse Bridges, Vice President Union Trust, A. B. Chandler, Manager of Foote's Kings Mountain Plant, Cecil L. Gilliatt, Chairman, Shelby Chamber of Commerce, W. W. Crawley, President Shelby Chamber of Commerce, Mayor C. M. King and W. T. Covington, Charlotte attorney.

LUBRICATE FOR SAFETY EVERY 1,000 MILES

SUPPLIERS OF MATERIALS FOR MANUFACTURING LUBRICATING GREASES

MANUFACTURERS OF EQUIPMENT FOR APPLICATION OF LUBRICATING GREASES

DARLING'S

STEARIC ACID
OLEIC ACID
RED OIL
FATTY ACIDS

DARLING & COMPANY *Manufacturers*
4201 South Ashland Avenue • Chicago

ALUMINUM STEARATE

MORE THAN 30 YEARS OF CONSTANTLY IMPROVING QUALITY

•

EXTREME JELL
AND
HIGH JELL GRADES

•

Synthetic Products Co.
LONDON ROAD & EUCLID AVENUE
CLEVELAND, OHIO

ZEE LINE

PROMOTIONAL LUBRICATING EQUIPMENT
Sold Exclusively
TO AND BY THE OIL INDUSTRY

NATIONAL SALES, INC.
812 NORTH MAIN • WICHITA, KANSAS

LEAD NAPHTHENATE
(liquid & solid)
LEAD OLEATE
ALUMINUM STEARATE

THE **HARSHAW CHEMICAL** CO.
1945 East 97th Street, Cleveland 6, Ohio
BRANCHES IN PRINCIPAL CITIES

LUBRICATE
FOR
SAFETY
EVERY
1000
MILES

For
QUALITY GREASE MAKING
- Neutral Oils
  Viscous and Non-Viscous
- Bright Stock
- "G" Cylinder Stock
  UNIFORM, DEPENDABLE

Write today for samples, prices and availability

DEEP ROCK

DEEP ROCK OIL CORPORATION
Atlas Life Building, Tulsa 2, Oklahoma

Technical Committee Column

Chairman T. G. Roehner, Director of the Technical Service Department, Socony-Vacuum Laboratories

The NLGI Technical Committee, at its Annual Meeting on October 31, initiated studies of three prospective projects. Three subcommittees will be established to consider the pros and cons of the projects and submit a report to the Technical Committee, at least by the next Annual Meeting.

The first project involves the preparation of a manual which would bring together in one publication, in summarized form, the information which is now distributed in a number of sources, including ASTM Standards on Petroleum Products and Lubricants. This work will recognize requests received from consumers and others not intimately connected with the lubricating grease industry for definitions of terms peculiar to that industry. These terms constitute the language frequently used when discussing lubricating greases and mostly originated with laboratory tests. There is some question as to whether definitions of those terms and methods should include the scope of their significance. In fact, one of the main responsibilities of the Subcommittee on this project will be to define the desirable limits of the project.

The second proposal was discussed at the 1950 as well as the recent meeting and has been the subject of considerable correspondence. Its objective is connected with the problem of informing the general public regarding the important part lubricating greases play in industry, transportation, and the armed services. Without lubricating greases, trucks, buses and passenger cars would grind to a stop. They are essential components of household vacuum cleaners, food mixers, etc. Fighter aircraft and guided missiles require unique lubricating greases in order to obtain reliable operation. It was proposed that a movie be made to tell that story to colleges, schools, business meetings, etc. A subcommittee will study the ways and means for acquiring such a movie and will report at the next meeting of the Technical Committee.

Consideration of the third project was prompted by the reaction to Mr. Hugh L. Hemmingway's article, "Is Wheel Bearing Lubrication Progressing?", in the July 1951 issue of the Spokesman. Therein specific data were given demonstrating the extreme variations in present practices covering each important operation for packing front wheels of automotive vehicles. It was decided that a subcommittee would be formed to study the practices now recommended in Owner and Shop Manuals of leading passenger car, truck or bus, and bearing manufacturers, and also the instructions issued by lubricating grease manufacturers to their service personnel. After this study, it is hoped that the subcommittee will formulate a recommended practice which will include the best points found in that review. Before publication of their decision, the results of their work will be reviewed with other organizations interested in the lubrication of wheel bearings.

The memberships of these subcommittees will be given in this column as soon as they are established.

Retiring President Howard Cooper

Praises N. L. G. I. Growth

in His President's Address at Annual Meeting

Howard Cooper

Gentlemen (and ladies)—representatives of member companies and our guests—on behalf of the officers and directors I bid you welcome to this 19th annual meeting of the National Lubricating Grease Institute. From the humble beginnings of its organization in 1933, which was inspired by the far reaching vision of three active grease manufacturers (one of whom is today a member of the Board of Directors), the N.L.G.I. has steadily grown not only in size but in stature, to attain a position of respect and force in the field of lubricating grease, its manufacture and usage.

In the early days, there were hard times and difficult years, when it might have been easy to give up; but resolution and steadfastness of purpose would not allow that to happen. Much credit and gratitude is due those stout hearts who refused to let determination and confidence be shaken by what they rightfully believed were temporary conditions.

There is no intent at this time to review the history of N.L.G.I. but it seems not inappropriate to mention in a few words some of the progress, the activities and the ambitions of the Institute, which will convey an understanding of the solid footing on which the Institute stands, and will remind member companies and reveal to our guests the constructive objectives to which the N.L.G.I. is committed.

The strength of the Institute is evidenced by the character of the membership and by the interest which the Institute has attracted beyond the confines of the United States. Factually the N.L.G.I. is no longer national, but is international in its scope of influence. Our list of members includes six active grease manufacturing companies in foreign lands and one organization in the technical membership group — in Canada, Mexico, Switzerland and Portugal. We are flattered by and proud of this recognition by our neighbors and from across the Atlantic. Also, during this past year from within the United States there were received as active members five grease manufacturing companies, plus three associate members and two technical members. This is further evidence of growth in strength and acceptance. It would be difficult to determine exactly the proportion of the grease manufacturing industry that is represented by the active members in N.L.G.I., but it is conservatively estimated that the grease manufacturing active members in the Institute account for close to 95% of the poundage of lubricating grease manufactured in the United States.

There is encouragement also in the interest being shown by research organizations which qualify for the classification of technical members, for this reflects the acceptance of lubricating grease manufacture as an activity of scientific standing.

The respect in which the N.L.G.I. is held is further indicated by the fact that the Institute Spokesman goes to 175 subscribers in many countries outside the United States. These countries include Great Britain, France, Belgium, Holland, Denmark, Sweden, Hungary, Germany, Spain, Portugal and Italy in Europe; in Central America—Cuba, Costa Rica and Colombia; and such far off places as Egypt, Union of South Africa and Australia. This recognition of and interest in the Institute and the support it is receiving from all classes of membership could not have been attained nor will it be sustained unless there had been and will continue to be constructive accomplishment.

The purpose of N.L.G.I., and its reason for existence are aptly presented in this extract from the Constitution:

ARTICLE III—PURPOSES

1. The purposes of the Institute shall be:

(a) To act as a clearing house for the collection of lawful information pertinent to the manufacture and use of lubricating grease, and to disseminate such infor-

mation to manufacturers, marketers and consumers of lubricating grease and to the public.

(b) To promote the advancement of research and practical tests in the field of lubricating grease manufacture and use.

(c) The study of product classifications and methods of tests; their development in cooperation with other technical societies; the publication of such data for the information of manufacturers, marketers, consumers of grease and the public.

(d) The collection of lawful technical information with respect to:

(1) New or improved methods of grease manufacture.

(2) New or improved equipment for manufacturing grease.

(3) New or improved shipping containers for grease.

(4) New or improved equipment for dispensing grease.

(5) New or improved devices for applying grease.

(6) New consumer requirements for lubricating greases.

(e) The fostering of such industry policies as will tend to maintain free and open competition among manufacturers and all classes of trade who serve in distributing the products of the industry.

Achievement of the aims and objectives as set forth in the Constitution is of much importance and for the benefit of those, principally among our guests, who may be unaware of some of the major activities, a few of them can be cited.

Already, and for some years, the N.L.G.I. classification of greases by penetration ranges has received nationwide and some international acceptance. More often than not, grease consistencies are now specified in terms of N.L.G.I. numbers rather than by penetration limits, although when ranges are used they generally coincide with those of the N.L.G.I. numbers.

While many activities can be considered as wholly within the province of the Institute, an examination of the Article III of the Constitution cited above reveals that if the objectives are to be realized to the fullest the N.L.G.I. cannot go it alone. Utmost accomplishment would not be possible without cooperation. Realizing this the N.L.G.I. has sought out opportunities for and has welcomed joint activities with other industries to investigate problems of mutual concern. These have been fostered and put in motion by the Technical Committee of N.L.G.I., and accomplishments have been gratifying. Among these is the joint study of grease dispensing which has made the manufacturers of grease dispensing equipment more familiar with the products which their devices are expected to handle and has brought to the grease industry an understanding of some of the difficulties that these manufacturers encounter in trying to provide economical equipment that is widely applicable for the many kinds of lubricants that are marketed. Any feeling of distrust or of disregard for each other's opinions that may have existed at one time has been largely cleared away through this joint effort in trying to arrive at a solution to something which both sides recognized to be a problem. This work is still going on but out of it so far has evolved a method of test through which dispensing equipment can be rated in terms of the properties of the greases it will dispense. This N.L.G.I. Dispensing Test was the result of many months of intensive work on the part of a panel composed of representatives of dispensing equipment manufacturers and lubricating grease manufacturers. It was published in the May issue of the Institute Spokesman with the hope that those interested in this important matter would provide themselves with the apparatus, and through data accumulated be able to add further to the knowledge acquired through the panel's studies.

Another cooperative study which is yielding interesting returns is the activity of the joint committee of NLGI-ABEC—(the Annular Bearing Engineers Committee) to examine grease test methods. Obviously both groups are concerned with the satisfactory performance of annular bearings; both are anxious to develop products and practices which will accomplish this most effectively. It is doubtful that the desired end could ever be attained if both sides continued to go separate ways each having an inadequate understanding of the other's products, and the factors of design, construction, composition and operating capabilities, all of which have an influence on effective lubrication.

It is interesting to observe here that this joint committee is about to be expanded to include also the RBEC (Roller Bearing Engineers Committee of Anti-Friction Bearing Manufacturers Association), who have requested opportunity to participate in this activity; on such occasion the committee will doubtlessly adopt the name AFBMA-NLGI Cooperative Committee on Grease Test Methods. A service emanating from the work of this group has been the issuance of technical bulletins on

1. Tentative Method for Determination of Low Temperature Torque Characteristics in Anti-Friction Bearings.

2. Tentative Method for Determination of Performance Characteristics of

Lubricating Greases in Anti-Friction Bearings at Elevated Temperatures.

3. The Norma-Hoffman Oxidation Test for Lubricating Greases.

The three-way cooperative activity of the railroad operators, bearing manufacturers and lubricating grease manufacturers in the Joint Committee on Lubricating Greases for Railroad Anti-Friction Journal Bearings is similar. In a study of this problem the railroad operators can supply from their experience the conditions which the bearings and the lubricants must face in service. The bearing manufacturers can supply data on design and performance characteristics that are factors which the lubricant must be prepared to meet; and the lubricant manufacturers, with their understanding of the capabilities of greases of different character, may help to avoid wasteful considerations of products that are known to be unsuitable while at the same time may prosecute the development of lubricants better able to achieve the objectives of long term satisfactory service which are of primary interest to the operators.

The N.L.G.I. has established cooperative relationships with other technical societies and groups, such as

1. The Lubrication Committee of the American Petroleum Institute.

2. Society of Automotive Engineers.

3. American Standards Association.

4. Technical Committee of the American Society for Testing Materials, and others.

The time has been taken to mention these cooperative activities, not just to advise the uninformed of some of the things N.L.G.I. is striving to accomplish, but because in this atmosphere of strengthening our defenses there is a compelling need for cooperation. We think that it is well that there is already set up not only an organization such as the N.L.G.I. that is prepared to cooperate with other groups, but that there has been experience in cooperation. It may be considered by some that all that cooperation means in activities such as those described is for a few persons of each group to get together and start to work on the solution of a problem at hand. I sat through an organizational meeting of one of these cooperative groups and I assure you that it is not quite that simple. There are many details to be ironed out, not least of which is an agreement on the objective. Having arrived at a decision on that point then there must be considered how it will be approached and the means and methods that will be required for its accomplishment. Experience in organizing activities of this sort is a valuable background, so it is repeated that the position of N.L.G.I., through its cooperative committees already working, and through the demonstrated spirit of willingness to cooperate with other groups, is of particular significance at this time when our defense activity may call upon all industries for more and more cooperative efforts. The

requirements of the military, and the specialized demands of combat equipment emphasize the necessity for pooling all knowledge and experience. The military services with all their accumulated information and facilities singlehanded cannot produce the lubricants which most effectively will best implement our fighting men in their combat endeavors and lead them to victory. A widely publicized phrase is fitting at this point, namely, "Defense is Everybody's Business." Cooperative effort contributes to the creation of a stronger defense.

Also, in the spirit of the stated purposes as set forth in the Constitution is the promotion of education and research that will serve the grease manufacturing, marketing, and consuming industries. The N.L.G.I. has long felt an obligation to foster fundamental studies (which factually means investigations that are in the realm of pure science), that will develop basic facts useful by others who may proceed with practical research toward the production of improved products which will better serve the operators of grease lubricated machinery. The first step in this direction was the establishment this year at the University of Southern California of the N.L.G.I. Fellowship in Colloidal Science. We are fortunate that during this meeting it will be possible to present to you an outline of the work that has been inaugurated with some progress comments.

Because some of these activities are being carried on without much publicity, by the Technical Committee and in subcommittees and panels of that committee and by the Institute as a whole, it was felt that perhaps our guests, and maybe some of our member companies, might not fully realize the truly constructive program which is not merely being endorsed and approved by N.L.G.I. but which is actually being prosecuted toward accomplishments that will be to the benefit of the grease manufacturer, the grease marketer and to that very important segment of all business—the user or consumer.

It is firmly believed that the acceptance of N.L.G.I. as an organization of strength and stature in the lubricating grease field is due to recognition that the Institute is actively engaged in efforts to carry out the stated purposes as set forth in the Constitution.

In starting out to prepare these remarks, it was not contemplated that they would turn into a "State of the Institute" message. Yet there is no more appropriate time for such a report or more appropriate audience to which such should be presented. You should know that in giving support to the Institute you are not backing an unknown horse with uncertain prospects. The N.L.G.I. is alive, and is doing things. It has earned wide respect, and is recognized as a dominating force in its field. It will be the determination of the administering officers and directors to carry the N.L.G.I. to further and more impressive accomplishments.

NLGI—

19th Annual Meeting Has Record Attendance

It was quite some time ago, 1933 to be exact, when the National Association of Lubricating Grease Manufacturers met in Chicago for their first Annual Meeting. A grand total of 46 people attended that meeting with a considerable sense of pride that their organization included 22 company members.

The 19th Annual Meeting of the National Lubricating Grease Institute also met in Chicago at about the same time of the year in 1951. This time 446 people registered for the meeting and the organization had grown to include 120 company members.

This year the NLGI proudly viewed both a record breaking attendance and membership. Each had considerably exceeded dreams of the founders and somewhat dumbfounded even present day membership.

Following out the pattern established at the first annual meeting in 1933 and observed since, the three-day session was largely devoted to technical papers regarding the application or manufacture of lubricating greases, as has been the custom in recent years. The third day was entirely devoted to the Technical Committee session with T. G. Roehner, its Chairman, presiding.

THE FIRST SESSION

The Monday morning session heard President Howard Cooper deliver an inspiring opening address characterized by a brief outline of growth and achievements to date. Particularly stressed was the contribution our organization is making to industry progress through cooperative endeavor with other organizations in the petroleum and allied industries. His complete address of welcome is on page 34.

Monday afternoon presented two papers of similar aspects devoted to the study of electron microscopy. The first was presented by Dr. Robert D. Vold, Department of Chemistry, University of Southern California. It was primarily a progress report of the NLGI Fellowship established last year for the study of colloid chemistry of soap-hydrocarbon systems. His subject: "The Structure of Gels of Hydrous Calcium Stearate in Cetane, Rheological Studies and Electron Microscopy."

Dr. Vold has headed the Fellowship during the first year of its inception. His contribution to the field of pure science is the first venture by the Institute into the realm of industry progress through industry cooperation.

His presentation was followed by Sinclair's J. A. Brown who presented an equally interesting presentation on the same subject. The final paper was contributed by Glen H. Morehouse on "Grease Milling & Deaeration."

He came greatest distance . . . Herman P. W. Wanner, Managing Director of Odolphe Schmids Erben Company travelled from Berne, Switzerland to attend meeting. His Company is first outside North America to join N L G I. Two others have since joined from Mexico and Portugal.

ELECTION OF BOARD MEMBERS AND OFFICERS

The Annual Business Meeting immediately followed with the Active Members present unanimously electing Mr. M. R. Bower, Mr. A. J. Daniel, Mr. F. E. Rosenstiehl, Mr. G. A. Olsen, Mr. W. H. Saunders, Jr. and Mr. B. G. Symon as members of the Board of Directors.

Then came the Board of Directors Meeting called for the purpose of electing officers for 1952. They unanimously elected George E. Merkle as President, W. Wayne Albright, Vice President and C. B. Karns was re-elected Treasurer. Mr. Merkle will be the 19th President to serve NLGI and Mr. Albright, the 18th Vice President. Mr. Karns is the third Treasurer and has twice been elected

Upper Left — B. G. Symon, Retiring President Howard Cooper and A. J. Daniel Discuss Institute affairs prior to a Board of Directors meeting.

Upper Right — At a Board meeting these Directors pose for photo: W. H. Oldacre, L. W. McLennan, H. L. Hemmingway, M. R. Bower, G. F. Olsen, J. R. Corbett.

Center — New Officers for 1952. Left to right: C. B. Karns (Treasurer), George E. Merkle (President) W. Wayne Albright (Vice-President) and Executive Secretary, Harry F. Bennetts.

Lower Left — Other Directors visit, F. E. Rosenstiehl, H. A. Mayor and R. Cubicciotti.

Lower Right — Technical Committee Chairman, T. G. Roehner.

Some of the Speakers

Above—C. E. Davis

Left—Robert D. Vold

Below—Clifford C. Goehring

Above—D. G. Proudfoot

Below—John A. Brown

Vice President of the Institute, which explains the difference in the number of vice presidents and presidents elected throughout the years.

SOCIAL HOUR AND BANQUET

Attendance at the Social Hour and Banquet eclipsed all past records for these two events. A total of 390 persons attended the Social Hour and 350 were present at the Banquet, with no check on the number of individuals who unfortunately were turned away because of the lack of accommodations.

TUESDAY SESSIONS

Highlighting the Tuesday morning session was a paper on Wheel Bearing Grease Complaints delivered by Mr. D. G. Proudfoot. Not strictly technical in nature it did attract considerable attention to the extent demands for reprints far exceeded the supply. This demand is being met by a number of reprints now being run. They are available through the NLGI Office.

Other speakers on the Tuesday morning session were Dr. Carl V. Kelley, Munitions Board, and T. G. Roehner, Chairman of the NLGI Technical Committee, who delivered a paper on "Fretting Corrosion." The final paper considered the Band Type Viscometer delivered by H. H. Hull.

The final session where technical papers were offered was on Tuesday afternoon with Mr. Clifford C. Goehring discussing Steel Industry Lubrication Problems from a sales engineers point of view. This was followed by a paper from the Naval Research Laboratory with the final paper devoted to the subject of Teaching the Principles of Lubrication to Engineering Students. Professor W. J. Ewbank of the University of Oklahoma offered the final paper.

Widely attended was the Technical Committee Session which met Wednesday morning, adjourning at noontime. Here reports were given by various chairmen heading panels and subcommittees of the Technical Committee. Of particular interest was discussion surrounding new projects that could be undertaken by this group.

The general consensus of opinion following the 19th Annual Meeting was that it was by far the largest in NLGI history and certainly the most enthusiastic. Particularly notable was the number of organizations represented who had never previously attended an Annual Meeting and the distance some had traveled in order to reach it. The longest distance traveler was Mr. Hermann P. W. Wanner, Managing Director of Adolf Schmids Erben, Inc., who came from Berne, Switzerland. His company is an Active Member of NLGI, joining during the past year.

GIVE THEM THE CREDIT

Complete credit for an outstanding meeting goes to President George E. Merkle who served as Chairman of the Program Committee and planned the entire affair. Assisting him as members of his committee were: W. W. Albright, J. R. Corbett, R. Cubicciotti and H. P. Hobart.

From an achievement and managerial standpoint full credit must go to past president, Howard Cooper. It was under his leadership that the NLGI inaugurated its Fellowship and a full program of cooperation with other petroleum and allied organizations.

PATENTS AND DEVELOPMENTS

ALUMINUM SOAPS

A patent recently issued to American Cyanamid Company (U. S. 2,572,429) covers a soap composition, suitable for greases, consisting essentially of the aluminum salt of a mixture of about 1% to 20% by weight of dimerized polyunsaturated fatty acids of 18 carbon atoms and about 99% to 80% of monomeric fatty acid of 12-22 carbon atoms.

NEWS ITEMS

Gulf Oil Corporation advertised its improved Lubcote lubricant for open gears and wire rope, featuring increased adhesiveness, a film resistant to moisture and fumes, and ability to withstand extreme temperature changes without drying or cracking (Rock Products, 9/51, p. 15).

Shell Oil Co. advertised its new industrial E. P. lubricants (Macoma oils for enclosed gears, and Alvania grease for grease-lubricated bearings) (Iron Age, 10/4/51, p. 132).

FUTURE MEETINGS of Your Industry

DECEMBER, 1951

26-31 American Assn. for the Advancement of Science (annual meeting), The Bellevue-Stratford, Philadelphia, Pa.

JANUARY, 1952

14-18 Socy. of Automotive Engineers, Inc. (annual meeting), Hotel Book-Cadillac, Detroit, Mich.

FEBRUARY, 1952

3-8 American Socy. for Testing Materials (Com. D-2 on Petroleum Products and Lubricants), The Shoreham, Washington, D. C.

4-6 Missouri Petroleum Assn. (annual convention and trade exhibit), Jefferson Hotel, St. Louis, Mo.

18-19 American Petroleum Institute (Division of Marketing, Lubrication Committee meeting), Hotel Book-Cadillac, Detroit, Mich.

19-21 Iowa Independent Oil Jobbers Assn. (annual convention), Fort Des Moines, Des Moines, Iowa.

26-27 Wisconsin Petroleum Assn. (26th annual convention and equipment show), Milwaukee Auditorium, Milwaukee, Wisc.

MARCH, 1952

3-5 Mfrs. Standardization Socy. of Valve & Fittings Industry (annual meeting), Hotel Commodore, New York, N. Y.

11-13 Illinois Petroleum Marketers Assn. (annual convention), Hotel Sherman, Chicago, Ill.

12-13 Texas Oil Jobbers Assn., Inc. (annual spring convention and refiners & suppliers exhibit), Hotel Adolphus, Dallas, Tex.

11-14 National Assn. of Corrosion Engineers (annual conference and exhibition), Municipal Pier and Galvez Hotel, Galveston, Texas.

19-21 American Petroleum Institute (Division of Production, Mid-Continent district), Hotel Broadview, Wichita, Kans.

31 to Apr. 2 Western Petroleum Refiners Assn. (annual meeting), The Plaza Hotel, San Antonio, Tex.

APRIL, 1952

2-4 American Petroleum Institute (Division of Production, Eastern district), Hotel William Penn, Pittsburgh, Pa.

7-9 American Society of Lubrication Engineers (7th annual meeting and lubrication show), Hotel Statler, Cleveland, Ohio.

24-25 American Petroleum Institute (Division of Production, Rocky Mountain district), Gladstone Hotel, Casper, Wyo.

MAY, 1952

12-15 American Petroleum Institute (Division of Refining, 17th midyear meeting), St. Francis Hotel, San Francisco, Calif.

15-16 American Petroleum Institute (Division of Production, Pacific Coast district), The Biltmore Hotel, Los Angeles, Calif.

19-20 American Petroleum Institute (Division of Marketing, midyear meeting), The Copley Plaza, Boston, Mass.

JUNE, 1952

9-10 Chemical Specialties Mfrs. Assn. (38th mid-year meeting), Hotel Statler, Detroit, Mich.

9-14 American Petroleum Institute (Division of Production, midyear Standardization conference).

N. L. G. I. Associate & Technical Members....

Supporting Your Organization These Suppliers of Your Industry Hold Membership in the N.L.G.I.

SUPPLIERS OF MATERIALS FOR MANUFACTURING LUBRICATING GREASES

American Cyanamid Company
30 Rockefeller Plaza
New York City 20, New York
Member—A. Scharwachter

Archer-Daniels-Midland Co.
Chemical Products Div..
2191 West 110th Street
Cleveland 2, Ohio
Member—F. C. Haas

Armour & Co., Chemical Division
1355 West 31st St.
Chicago 8, Illinois
Member—Dale V. Stingley

Darling & Company
4201 South Ashland Avenue
Chicago 9, Illinois
Member—George W. Trainor

E. I. du Pont de Nemours & Company
Wilmington, Delaware
Member—J. R. Sabina

Emery Industries, Inc.
4300 Carew Tower
Cincinnati 2, Ohio
Member—R. F. Brown

Foote Mineral Company
18 W. Chelten Avenue
Philadelphia 44, Pennsylvania
Member—H. C. Meyer, Jr.

A. Gross & Company
295 Madison Avenue
New York City 17, New York
Member—Eugene Adams

W. C. Hardesty Co., Inc.
41 East 42nd Street
New York City, New York
Member—W. G. McLeod

Harshaw Chemical Company
1945 East 97th Street
Cleveland 6, Ohio
Member—G. G. Unkefer

Leffingwell Chemical Company
P. O. Box 191
Whittier, California
Member—D. E. Murphy

Lubrizol Corporation
Euclid Station
Box 3057
Cleveland 17, Ohio
Member—J. H. Baird

Mallinckrodt Chemical Works
New York 8, New York
St. Louis 7, Missouri
Member—C. E. Cosby

N. I. Malmstrom & Company
147 Lombardy Street
Brooklyn 22, New York
Member—Ivar Wm. Malmstrom

Metasap Chemical Corporation
Harrison, New Jersey
Member—O. E. Lohrke

Monsanto Chemical Company
1700 Second Street
St. Louis 4, Missouri
Member—J. W. Newcombe

National Lead Company
105 York Street
Brooklyn 1, New York
Member—Alexander Stewart

National Rosin Oil Products, Inc.
R.K.O. Bldg., Rockefeller Center
New York City, New York
Member—Richard Bender

M. W. Parsons—Plymouth, Inc.
59 Beekman Street
New York City 38, New York
Member—H. Bye

Synthetic Products Company
1636 Wayside Rd.
Cleveland 12, Ohio
Member—G. B. Curtiss

Swift & Company Industrial Oil Division
165th & Indianapolis Blvd.
Hammond, Ind.
Member—F. H. Beneker

Warwick Chemical Company
Division of the Sun Chemical Corporation
10-10 44th Avenue
Long Island City 1, New York
Member—Dr. J. J. Whitfield

Witco Chemical Co.
6200 W. 51st St.
Chicago 38, Illinois
Member—B. W. Lewis

CONTAINER MANUFACTURERS

Central Can Company, Inc.
2415 West 19th Street
Chicago, Illinois
Member—Henry Frazin

Continental Can Co.
1103 Waldheim Building
Kansas City 6, Missouri
Member—T. A. Graham

Geuder, Paeschke & Frey Co.
324 North Fifteenth Street
Milwaukee 3, Wisconsin
Member—Willard J. Flint

Inland Steel Container Company
6532 South Menard Avenue
Chicago 38, Illinois
Member—G. D. Zuck

J & L Steel Barrel Company
405 Lexington Ave.
New York 17, New York
Member—Jerry Lyons

National Steel Container Corporation
6700 South LeClaire Avenue
Chicago 38, Illinois
Member—Henry Rudy

Ohio Corrugating Co.
917 Roanoke Ave. So. E.
Warren, Ohio
Member—L. F. McKay

Rheem Manufacturing Company
570 Lexington Avenue
New York, New York
Member—G. Wesley Gates

United States Steel Products Co.
30 Rockefeller Plaza
New York City 20, New York
Member—Wm. I. Hanrahan

Vulcan Stamping & Manufacturing Co.
3000 Madison Street
Bellwood, Illinois
Member—H. B. Scharbach

MANUFACTURERS OF EQUIPMENT FOR APPLICATION OF LUBRICATING GREASES

The Aro Equipment Corporation
Byron, Ohio
Member—R. W. Morrison

Balcrank, Inc.
Disney near Marburg
Cincinnati 9, Ohio
Member—R. P. Field

Gray Company, Inc.
60 11th Avenue Northeast
Minneapolis 13, Minnesota
Member—L. L. Gray

Lincoln Engineering Company
5701 Natural Bridge Avenue
St. Louis 20, Missouri
Member—Foster Holmes

National Sales, Inc.
812 North Main Street
Wichita, Kansas
Member—Howard Dearmore

Stewart-Warner Corp.
1826-1852 Diversey Parkway
Chicago, Illinois
Member—Walter Duncan

U. S. Air Compressor Company
5300 Harvard
Cleveland, Ohio
Member—C. A. Benning

LABORATORY EQUIPMENT AND SUPPLIES

Precision Scientific Company
3737 Cortland Street
Chicago 47, Illinois
Member—Alexander I. Newman

SUPPLIERS OF EQUIPMENT FOR MANUFACTURING LUBRICATING GREASES

Buflovak Equipment Division of Blaw-Knox Company
1543 Fillmore Avenue
Buffalo 15, New York
Member—Edward V. Hegg

Chemicolloid Laboratories, Inc.
30 Church Street
New York, New York
Member—David F. O'Keefe

The Girdler Corp.
Louisville 1, Kentucky
Member—John E. Slaughter, Jr.

Morehouse Industries
707 Henry Grady Bldg.
Atlanta 3, Ga.
Member—George E. Missbach

Stratford Engineering Corporation
1414 Dierks Building
Kansas City, Missouri
Member—J. W. Sylvester

REFINERS

Farmers Union Central Exchange, Inc.
P. O. Box G
St. Paul 1, Minnesota
Member—H. F. Wagner

Freedom Valvoline Oil Co.
Box G
Freedom, Pa.
Member—D. A. Smith

Mid-Continent Petroleum Corporation
Tulsa, Oklahoma
Member—T. E. Fitzgerald

TECHNICAL AND RESEARCH ORGANIZATIONS

Midwest Research Institute
4049 Pennsylvania
Kansas City 2, Missouri
Member—Dr. M. H. Thornton

Petroleum Educational Institute
9020 Melrose Avenue
Los Angeles 46, California
Member—G. A. Zamboni

Phoenix Chemical Laboratory, Inc.
3953 W. Shakespeare Avenue
Chicago 47, Illinois
Member—J. Krawetz

Sociedade Nacional de Petroleos
Rua D. Pedro V, no. 80
Lisbon, Portugal
Member—Manuel Cordo Boullosa